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OUR BEEF SUPPLY[1]

Act No. 3155 passed by the Philippine Congress, which prohibited absolutely the importation of cattle into the Philippines, was to go into effect April 1, 1925, but was suspended for one year by the joint action of the Governor General and the presiding officer of each of the houses of Congress. We anticipated such eventuality when we discussed this matter with members of the committees on agriculture of the legislature as a delegate of the Philippine Society of Technical Agriculturists.

Act No. 3155 has two defects in that it fails to recognize:

1. That while our beef supply may be adequate as claimed by the supporters of the act, our marketing organization is admittedly deficient as it does not provide for the bringing in of cattle to the Manila market regularly, expeditiously, and cheaply.
2. That certain provinces, notably Negros Occidental and Iloilo, are to a large extent dependent upon foreign sources of supply for their work stock, as they claim the Philippine supply is inadequate both in quality and quantity.

In our discussions with the legislative committee members we proposed some modifications to the amendatory bills being considered at the time, which we shall take up presently, as we were convinced that neither the law in its present form nor with the proposed amendments could become operative. The proposed amendments having failed of action, effort was made to enforce the law, as it stands, partially by limiting the number of animals to be brought in by regulation and general agreement. We wish the Secretary of Agriculture who is entrusted with the details of enforcing the modified law the best of luck in his efforts, but we have seen government regulation of economic problems fail so often that we feel much like the man from Missouri. Already there are rumors of scarcity of beef in Manila, as the importers find it difficult to adjust themselves to the artificial conditions imposed.

As to work stock, the government of Indo-China has stipulated that no work animals will be exported unless they are accompanied by a certain proportion of animals for slaughter.

Perhaps it is well that the premises of the question be examined:

1. It is a matter of record that some epizootics in the past have been directly traceable to imported live stock.

2. Local stock men, on the plea of protection from animal diseases, have sought the passage of a law prohibiting the importation of foreign cattle for slaughter. It is admitted by these stock men that at normal prices for foreign

[1] General contribution from the College of Agriculture No. 145.

cattle landed in the Philippines, they are unable to meet the competition, and as a result they cannot afford to market their animals.

The Philippine Congress heeded the plea, used its police powers and passed Act No. 3155 which forbids, absolutely, the importation of foreign cattle.

Obviously the law has two distinct aims:

(*a*) Protection of the live stock of the country from infection through foreign sources; and (*b*) Protection of the local live stock industry through restriction of trade.

From a broad national point of view the first aim admits of little discussion. Almost all civilized countries recognize that the traffic of animals brings its *sequela* of diseases, and countries with any stock industry have quarantine laws so strict that it is impractical to bring into them any but high class breeding animals. But such countries are not necessarily self-supporting as to meat. So refrigerated carcasses are allowed in with little restriction, and, in some cases, isolated slaughter houses, as in the Philippines, are provided for the proper handling of imported stock. There appears to be little danger of a disease spreading from either of these methods of handling meat. As with the quarantine protection the safety of the slaughter house method depends entirely upon the efficiency and integrity of the officers entrusted with the enforcement of regulations.

The real danger from animal disease comes from live animals imported for draft purposes. Strict quarantine regulations, immunization, and other preventive and prophylactic measures tend to minimize the risk, but our knowledge of animal diseases is so limited that oftentimes animals pronounced to be perfectly healthy turn out to be reservoirs of disease, thus infecting other animals and spreading contagion. Besides, in the routine work of isolation, testing, etc., only a few common diseases are guarded against, while others pass on unnoticed until they have assumed the proportions of an epizootic. To make the situation even worse, healthy animal carriers of one species often infect another; for example, surra is a disease that may be carried with little discomfort by bovines in general, but is highly fatal to horses. Contagious abortion is another disease that is likely to pass through the most rigid quarantine, and this disease affects practically all domestic animals.

From the point of view of disease control the law seems to be unnecessarily strict, as it has not been shown, as yet, that animals brought in the Philippines for immediate slaughter, and handled as they are at present, have been sources of infection.

As to the second aim of the law, the protection of the local live stock industry: This is such an age old controversial question in government that we are loath to enter into any discussion of it, as we would simply recapitulate the threadbare arguments pro and con. It is our belief, however, that the country is potentially capable of producing the beef requirements of the local market. It can now almost, if the marketing facilities met requirements. The most serious difficulty, it appears, is that animals are raised in comparatively small herds or singly in the Philippines. This necessitates a complicated system of collection, involving a number of middlemen, before a sufficiently large number of animals can be gathered for shipment; and facilities for handling them while awaiting shipment are inadequate. Such a system of marketing requires a considerable margin from the producer's selling price to the consumer's buying price. The

system can and does exist in the pork and poultry trades as, practically, there is no foreign competition in these commodities. But in the beef trade of the city of Manila, and in the work animal trade of Negros Occidental and Iloilo there is an effective foreign competition, which has been highly successful in destroying or at least curtailing the local system of marketing.

Another big problem is the small size of Philippine cattle, which tends to increase the cost of transportation. This can be remedied to a large extent through the improvement of breeding methods.

We believe that beef can be produced just as cheaply in the Philippines as it is in Australia and Indo-China. As a matter of fact, in many parts of the Islands right now cattle can be purchased at the same price per unit weight or lower than we pay for foreign cattle at their port of origin.

Instead of the drastic Act No. 3155, the promulgation of a beef tariff appears to us a better way to supply our meat market and at the same time foster our live stock industry. A large enough margin is necessary at the beginning to start the channels of trade going. This will be reflected, of course, in higher meat prices. It is believed, however, that this higher price will be but temporary, as the purveyors of the market are bound to increase and competition among them will follow. With this protection of the local trade, there will be an incentive to raise more animals. Just what the tariff ought to be, should be the subject of a thorough inquiry.

The greatest problem local cattle men face at present is their inability to market their surplus animals. Natural propagation of the stock forces them to carry too many animals within the same area to the permanent detriment of their range and their stock. And they are unable to extend their operations to unsettled regions for lack of fluid capital. The small size of Philippine cattle in many regions is due in large measure to overstocking.

As practically all imported work cattle and carabaos go to the provinces of Negros Occidental and Iloilo, if it can be shown that they cannot obtain the desired animals within the Philippines, then they should be allowed to import them as at present. Such provinces, however, should be declared as infected territory all the time they are open to importation and closely quarantined. No animals should be allowed to go from them to other provinces of the Islands.

Our live stock industry suffers at present from two vicious circles:

1. Due to the insufficiency of the local market supply foreign animals are brought in bringing diseases with them. These diseases work havoc among our animals thus curtailing local production of live stock and decreasing the supply available for the market, hence the importation of cattle and meat products.

2. To bring down the cost of meat to the consumers, live stock and meat products are imported. Local stockmen unable to make a profit on their venture at current prices leave their animals to their own resources. The neglected herds fall an easy prey to any rampant infection. When not annihilated by epizootics, they multiply rapidly, become wild and through lack of controlled breeding degenerate rapidly in size. The small and wild animals are difficult to catch, expensive to market, and are of little value to the trade, and thus there is insufficiency in the local meat supply. This forces the prices up and necessitates the bringing in of imported animals.

To recapitulate, we believe that Act No. 3155 fails to meet our real problem. It should be so amended as (*a*) to forbid the importation of work stock—cattle and carabaos—except to certain provinces, which shall then be considered as infected territory; and (*b*) a protective tariff law for cattle and cattle products should be requested of the United States Congress to foster the local animal industry while in its infancy. The vicious circle must be broken somewhere.

Jointly and independently, directly and indirectly, both of the above measures may be expected to increase the local supply of beef and work animals and thereby ultimately lower prices.

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PLOWS AND PLOWING II: A STUDY OF SOME TYPICAL FILIPINO NATIVE PLOWS[1]

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WITH ONE PLATE AND TWO TEXT FIGURES

Planters in the Philippines mostly use home-made native plows in their farming operations. Although implements of foreign make are slowly gaining favor, still a great majority of the Filipino farmers have yet to be convinced of their superiority over the older type of plows to which they are accustomed.

Plowing is undoubtedly the item in farm practice which demands the greatest expenditure of mechanical power. A large amount of such power must of necessity be consumed in the Philippines, in view of the common local practice

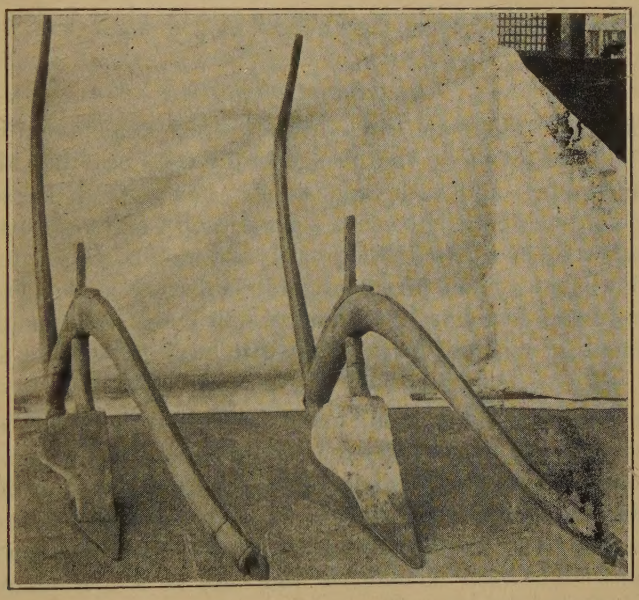

Fig. 1. Two general types of Filipino made plows.
One at right, type A, generally used for upland plowing.
One at left, type B, generally used for lowland plowing.

of plowing the field from two to seven times prior to planting. The present study has been undertaken in an effort to determine from a mechanical point of view the essential features of this useful adjunct to agricultural operation.

The object is two-fold: First, an attempt is made to describe the sources, the mechanism, and the construction of the various parts of the native plow; second, the determination of the action of these parts is made, as regards quality of work and of draft in the act of plowing.

[1] Experiment Station contribution No. 300.

MATERIALS USED

Two general types of plows were studied, and these were designated as follows: Type A, represented by a plow the bottom of which is adapted for use in both upland and lowland fields; type B, represented by a plow the bottom of which is fitted exclusively for use on soils that are either too wet or over-saturated with water during the time of preparation. (See fig. 1.). Type A, which is Filipino made, is generally used in the cultivation of corn, tomatoes, rice, and sugar cane fields; type B, which is Chinese made, is used in lowland rice culture only. More than twenty plows of each type were examined during the course of the present investigation.

RESULTS

Sources of plow parts

Filipino native plows are rarely sold ready-made. Some parts, as the moldboard and the share, are either bought as separate pieces from local hardware dealers or are ordered direct from manufacturers. Other parts, as the beam, the handle, the moldboard support, and the landside, are usually selected by the farmer himself from buttresses, trunks, and branches of hard trees in the forest, although these may occasionally be found on sale by plow dealers.

Description of parts

The moldboard. There are three distinct forms of moldboards used in type A plows. The form for plows that are generally used on stiff sod is of medium length, gently sloping, and with large twist. For very sticky soil, the moldboard is small, of medium length, with a gentle slope, and very little bend. For soils free from stiff sod or from sticky clay, the moldboard is steep, with little twist and a big bend. Some of these moldboards are so devoid of twist that they turn the furrow slice hardly more than half over. The moldboard in type B plows is small, of medium height, and with very little bend and very little twist.

There are three sources of materials for the manufacture of moldboard; cast scrap iron, imported pig iron, and white fine-grained iron. The Chinese-made moldboards are usually made either of cast scrap iron or of imported pig iron. The Filipino-made moldboards are cast out of a white fine-grained iron that contains very little graphitic carbon. They are low in silicon and are extraordinarily hard. The iron is reduced and cast at a low temperature. The cooling is done in the open air.

In some localities, Filipino blacksmiths make a limited number of moldboards out of discarded railroad rails. They hammer the material while red-hot until the desired shape is obtained. Farmers use this type of moldboard for very sticky soil or for soils where it is impossible to get the moldboard to scour.

Filipino-made moldboards are made in three sizes, the largest being about 3.5 kilograms in weight, the second, 2 kilograms, and the smallest 1.3 kilograms. Farmers use the largest size for sugar cane fields; the next, for corn, tomatoes, and upland rice fields; and the smallest, for lowland rice fields.

The bottom of the moldboard is provided with a pair of projecting rods by which it is clamped to the moldboard support. The front edge is beveled at the

bottom. This beveled area forms a bearing surface against the rear end of the share, making a good fit between the moldboard and the share.

The share. The share is shaped like an inverted V. The length is about 30 centimeters along the median line from the vertex to the base; the width at the base is about 13 centimeters; and the height of the base from the ground, about 6 centimeters. The vertex forms the penetrating point; the two edges which rise backward and form an inclined plane act as the cutting edges.

The share is provided with a vertical suction when cast. This suction in new shares measures from 3 to 6 millimeters. Some farmers do not find this suction satisfactory so they break off a portion of the point, and resharpen the cut end by means of a grindstone. The different suction is formed when the share is fitted to the landside.

The share is ribbed at the bottom from the rear end to within a few centimeters from the tip, where it flattens out and becomes confluent at the surface. In cross section, the share is subtriangular at the rear end, but gradually becomes obtuse toward the tip. The rear end of the share is hollow to accommodate the front end of the landside. The thickness of the metal at this region is about six centimeters.

Shares are never made at local blacksmith shops. Their size and shape are practically uniform, irrespective of the type of plow for which they are to be used. The material is similar to that of the moldboard. The share never governs the width of cut; it is always the moldboard that takes care of this work. Note how this differs from the modern American plow in which the share determines the width of the furrow.

The beam. The beam of the native plow is carved out of wood. It is usually bent near the rear end, as shown in plate I. The degree of this bend determines the beam clearance. Fully matured and well seasoned dungon (*Tarrieta sylvatica* Merr.) and bitik (*Shorea guiso* Bl.) are the two most commonly used hardwoods for this purpose. These materials are resilient and possess considerable transverse strength. A plow beam of this kind lasts for years, since it is resistant not only to insect attacks but also to the effects of the weather.

The landside. There is no important variation in the height, length, and shape of the landsides. The width usually tapers slightly from the front end to the rear end, while the thickness tapers slightly in the reverse direction. The width varies from 6 to 7.5 centimeters at the front end, and from 4 to 5.5 centimeters at the rear end. The thickness at the front end is about 5.5 centimeters and about 6 to 7 centimeters at the rear end. The average length of the landside, measured from the rear end of the share, is from 50 to 58 centimeters.

The landside is provided with two mortises; one for the attachment of the handle and one for the moldboard support.

The sole of the landside is protected by a replaceable iron cover that is usually made at a local blacksmith shop. This piece measures about 5 millimeters in thickness and is equal to the landside in length and width. Type B plows are not provided with this piece.

The kinds of wood that are often used for the landside are madre de cacao, or cacauate (*Gliricidia sepium* Steud), ipil (*Intsia bijuga* O. Ktze.) and dungon. Only the heart, which is the hardest part of the trunk, is used.

The moldboard support. The moldboard support, as the name suggests, supports the plow moldboard. It takes care of all the horizontal thrust acting on the moldboard. The front edge is slightly inclined backward. A tight connection is made possible by the use of a wooden pin and a wooden wedge; the latter being used only on the right side of the support.

The moldboard support is connected to the landside at the lower end, and to the beam at the upper end. A through-mortise and tenon-joint is used in each of these connections.

The two most common native materials used for the moldboard support are cacauate and ipil. These materials last long and are reasonably resistant to insect attacks. Furthermore, they can stand wetting and prolonged exposure to the sun, alternately, without appreciably changing in size and shape.

The cap. The cap may be fitted to the plow to cover the entire rear-end portion of the beam, as shown in plate I, or to cover only the upper portion of the beam above the moldboard support. In the former case the cap is long and it takes the shape of the rear end of the beam. It has a through-mortise near the front end. The rear end has a square neck by which it is fitted to the handle.

The cap is held in place and prevented from sliding upward along the tenon of the moldboard support by means of wooden pin. The square neck at the rear end (plate I) helps to keep the handle steady.

The materials that are commonly used for making caps are cacauate and ipil.

The handle. The end of the handle may curve either upward or downward. This end can neither be raised nor lowered without injury to the beam and the landside. The height of the handle is set in a permanent position when the plow is assembled.

The mortise at the handle is purposely made long so as to accommodate the beam-tenon, the square neck of the cap, and a wedge. This wedge, which may be placed either above or below the beam-tenon, shifts the front end of the beam either up or down to vary the depth of plowing.

Cacauate and ipil are the most common native materials used for making the handle.

The clevis. The vertical clevis, which is made of iron, is attached to the front end of the beam by means of two collar rings. The hook at the end of the clevis determines the height of hitch. There is no horizontal clevis to regulate the width of cut. It is the usual practice to have the clevis made at some local blacksmith shop.

Other plow accessories. The native plow is provided with a *dirt cleaner* which may be made either of bamboo or of galvanized iron. It is shaped like a knife with a hole at one end. This hole is fastened to the tenon of the moldboard support when the cleaner is not being used.

Another part called the *furrowing board* is used for furrowing only in sugar cane plantations. The board, which is about two or three centimeters thick, is trapezoidal. The upper base measures from 25 to 30 centimeters; the lower base, 15 to 20 centimeters; and the height, from 25 to 32 centimeters. When used, it is screwed at the center behind the moldboard support; and a boy or a girl weighing about 10 kilograms sits on it. Sometimes the moldboard is removed and the furrowing board substituted.

Any kind of wood, preferably molave (*Vitex parviflora* Juss.) can be used for this purpose.

Assembling plow parts

The plow is assembled by an expert, of whom there may be two or three in the average community. The farmer supplies the expert with all the necessary materials.

In the process of assembling, the landside and the share are joined first. A vertical suction varying from 5 to 11 millimeters is provided when these two parts are adjusted for type A plows. For type B, the vertical suction is made to vary from almost 0 to 4 millimeters.

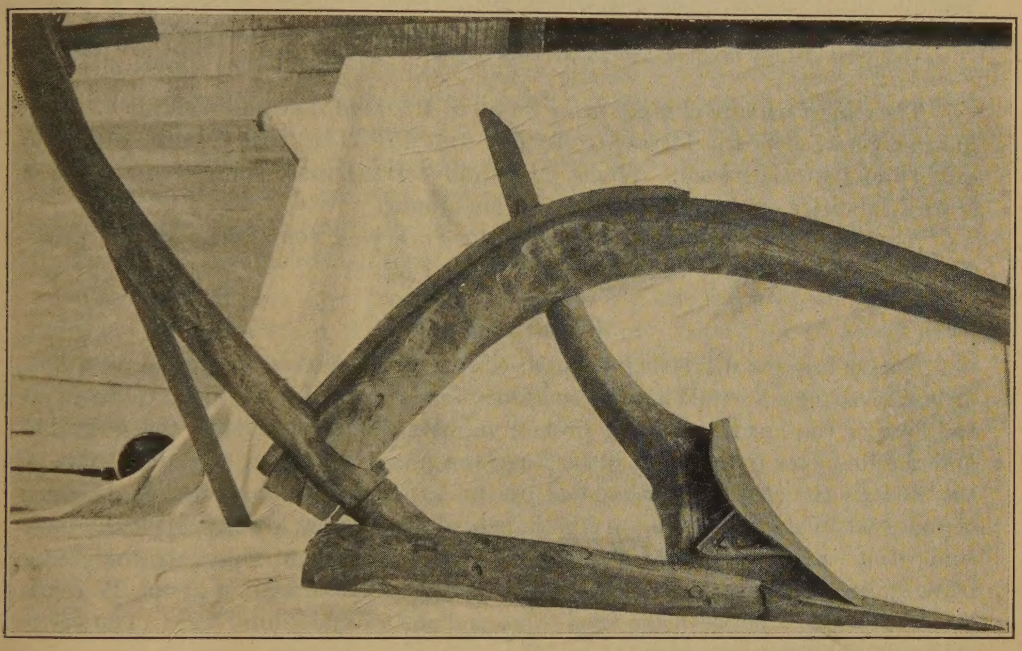

Fig. 2. Side view of type B plow. Note the absence of vertical suction.

The handle, the moldboard support, the cap, and the beam are then added. The moldboard support is set with a degree of inclination that will give the moldboard the desired steepness when clamped. The steepness varies with the form of moldboard used.

The expert generally makes satisfactory adjustment of plows that are used in his particular locality. His knowledge of soil conditions and of the quality of the work turned out by some of the plows enables him to work out the requisite adjustments.

The different parts of the plow are assembled without the use of a single bolt or nut. Tight connections are made possible by the use of only wooden wedges, wooden pins, and perfect fittings.

Price of materials

The following table gives the approximate prices of the different materials used for the plows.

TABLE 1

Prices of the different materials composing the native plow

NAMES OF PARTS	MATERIALS	APPROXIMATE MARKET PRICE OF MATERIALS
		pesos a
Moldboard	Fine white gray iron, steel, scrap iron	2.00 to 6.00
Share	Fine white gray iron, steel, scrap iron	0.80 to 1.20
Beam	Bitis, dungon, cacauate	3.00 to 5.00
Landside	Cacauate, ipil, dungon	0.80 to 1.20
Moldboard support	Cacauate, ipil, dungon	0.80 to 1.20
Cap	Cacauate, ipil	0.40 to 0.60
Handle	Cacauate, ipil	0.80 to 1.20
Clevis	Iron	0.40 to 0.60
Tree	Cacauate, ipil	0.50 to 1.00
Yoke	Cacauate, ipil, dungon	0.80 to 1.20
Landside shoe	Iron	0.80 to 1.20

[a] One peso (₱1.00) is equivalent to 50 cents ($0.50) U. S. currency.

The expert usually charges from ₱4.50 to ₱5.00 for assembling a plow. The finished plow costs the farmer from ₱10 to ₱25. The cost varies with the quality of materials used. Where the supply of the most suitable materials is scarce, the price of the plow reaches its maximum.

A used plow that has been proved to work well commands a high price. The usual price for this kind is from ₱25 to ₱30.

Methods of hitching

Native farmers drive their animal, which may be either a carabao or a bullock, with a single line. With experienced animals one end of the line is tied around the base of the horns; in newly broken animals the line is tied to the nose ring and the line goes over the head between the horns, and then to the left side of the animal; the other end is handled by the left hand of the plowman. A piece of rope, rattan, rubber hose, or vine is passed around the lower part of the neck connecting the two ends of the yoke. This arrangement prevents the yoke's being pulled away from the neck of the animal. A clearance of about 25 centimeters is allowed between the single-tree and the animal's hind feet. The vertical angle of hitch varies from 11 to 16°.

The animal is so trained that with the use of the single line, a steady pull makes it go to the left and a jerk, to the right. Certain peculiar exclamatory calls as "La-a", "Ho", "Ha", etc., are used either to start or to halt the animal.

Quality of the work

The point of the share does not have a gradual wedge-shaped point; it cuts the furrow slice with a nearly triangular bottom. The point of the share hits the middle of the furrow bottom and not the bottom of the furrow bank. The outer corner of the left wing of the share extends beyond the plane of the landside and cuts the furrow bank horizontally near the middle. The sharp bend at the meeting point of the share and the moldboard breaks the gradual rise of the furrow slice. Sometimes, roots of plants are caught in the sharp bend when the connection is loose.

The furrow slice slides upward on the upper surface of the share. The downward thrust at this place is cared for by the point of the share when the vertical suction is not destroyed. When the point becomes dull, suction is destroyed,

and this downward thrust is cared for by the bearing surface at the rear lower end of the rib of the share. As the furrow slice is raised on to the moldboard, the downward thrust at the center of the plow is cared for partly by either the rib or the point of the share, and partly by the bearing surface of the landside sole. In the case of the type B plows practically no vertical suction is provided and the point supports no downward thrust.

The point of the share does not bend into the land out of the plane of the landside. The upper surface of the share does not slope to one side. On this account the landside is kept from coming in contact with the furrow wall as the furrow slice is cut and raised on to the moldboard. When the moldboard receives the furrow slice from the share, and inverts or partially inverts it, a side thrust is exerted on the plow, making the rear end of the landface of the landside form a bearing surface against the furrow bank.

The height of the landside very closely approaches the depth of the furrow in the first plowing. Farmers learned from experience not to plow any deeper than this, otherwise there would be too much pressure exerted by the furrow slice on the moldboard. On this account, the clods would not be well pulverized and not well turned in the first plowing. The furrow crown does not have a uniform height and curvature because the furrow slice oftentimes rolls back to the furrow. The trash is, in most cases, only partly covered.

The depth of plowing is increased from 3 to 5 centimeters at each successive plowing. The quality of the work improves as the number of plowings is increased. The condition of the soil is changed each time the field is plowed and harrowed. At the third, fourth, and fifth plowings, the furrow slice is pulverized better and is turned over more uniformly.

One plowing is all that is required for lowland rice fields. It is the object in this plowing to crush and invert, as much as possible, the upper layer of the wet soil. The field is kept under water after this plowing and is harrowed and puddled several times before planting.

Drafts

A number of preliminary tests made by the writer on the draft of native plow of type A showed the following results:

Draft per square centimeter of furrow section

Clay loam, moderately dry, weedy	289	grams
Silt loam, moderately moist, weedy	280	"
Loamy clay, ideal, not very weedy	291	"
Loamy clay, very dry and hard	313	"
Clay loam, corn stubble	244	"
Clay loam, second plowing	188	"
Clay loam, third plowing	124	"

The speed of the animal varies from 0.8 to 2.0 kilometers an hour. The average depth of plowing is from about 7 to about 9 centimeters for first plowing, about 10 to 13 centimeters for second plowing, and from 15 to 18 centimeters for third plowing. The average width of the furrow is from about 15 to about 24 centimeters in each case.

CONCLUSIONS

The types of native plows here described will probably continue to be the principal tillage implement on Philippine farms until a new type which is better fitted for the important work of plowing is obtained. Native farmers find the plows to be very simple in construction, very light, and easy to manipulate. They can be used conveniently to plow out corners of small fields.

Plows of type A are designed to break up the surface of the soil in first plowing rather than to pulverize it. The farmers have to plow the land at least twice before a mellow seed bed can be produced. It would not seem economical to continue this practice for, as the population increases, better and more thorough methods of tillage will be necessary to increase the production. The plow now used must be improved to save time and labor on the farm.

All the parts composing the plow, outside of the moldboard and share, are made of wood. Material for those parts is abundant in most localities and the supply will probably remain sufficient until agricultural areas so multiply in size that the demand is greatly increased. The wooden parts are advantageous in some respects for they either break or spring back to their original positions when subjected to stress. If the parts were made of steel, they might be wrenched out of shape without the change being detected, and thus give the plowman trouble.

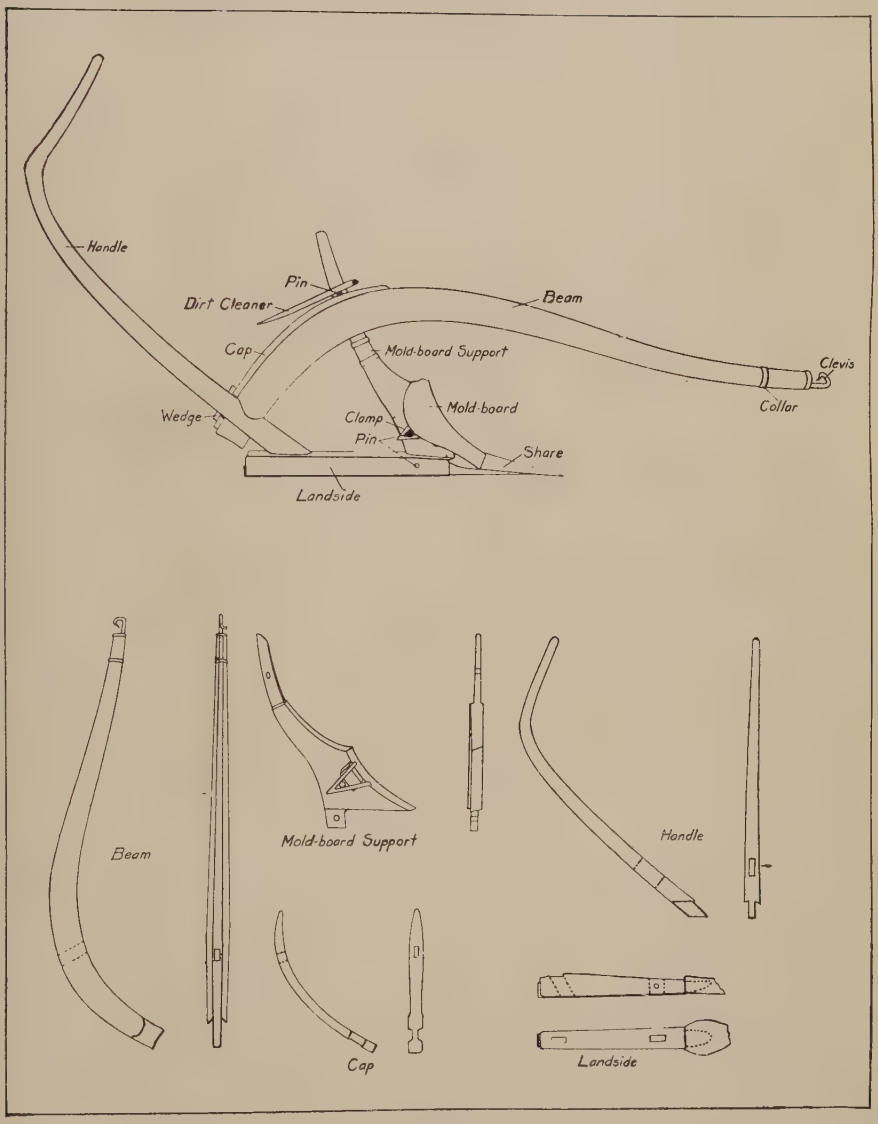

PLATE I

Plow parts and plow assembled

A STUDY OF SOFT CHEESE MAKING[1]

MAMERTO E. LIMUACO

INTRODUCTION

Milk and other dairy products consumed in the Philippines represent a large proportion of the country's imports. Home dairy products are not unpopular, for wherever a local dairy is in operation there are sufficient returns from the venture to enable a number of people to earn their living from the enterprise.

As dairying expands, the production of market milk will naturally increase to the extent of producing a surplus that will have to be disposed of in some way. Such surplus, if the business is to be made a paying proposition, will have to be turned into some useful product, such as butter and cheese. Certain dairies may even concentrate their attention on soft cheese making as their specialty.

A method of making cheese in Bulacan was reported in the Philippine Journal of Science (1913) describing the cheese as made by warming the milk, then coagulating the fat and protein by adding vinegar and salt. The whole is poured into a bamboo tube fitted with a piston by means of which the curd is compressed in the bottom of the tube and the whey forced out through small apertures on the sides and through the porous partition of the bamboo. The resulting curd is white in color and tough in consistency. A chemical analysis of this cheese is here tabulated:

CONSTITUENTS	SAMPLE I	SAMPLE II	SAMPLE III
	per cent	*per cent*	*per cent*
Moisture	51.55	50.00	56.00
Milk fat	27.14	28.91	29.37
Protein (n. × 6.25)	15.52	15.17	15.71
Acetic acid	00.112	00.029	00.00
Lactic acid	00.195	00.48	00.00
Insoluble ash	1.48	1.64	1.76
Soluble ash	3.45	4.27	4.01
NaCl	0.43	0.447	0.00

Another investigation bearing on soft cheese making in Laguna and Bulacan is given by Mendoza (1917). In describing the method of making the Laguna cheese he gives rennet extract as the coagulant used.

Objects of work

The objects of the present study were: (*a*) To conduct a survey on the process of making native soft cheeses; (*b*) To collect data on the economic and marketing phases of the native soft cheese industry; (*c*) To determine by actual tests, and production records, means of improvement over the practices in vogue.

[1] Thesis presented for graduation, 1924, with the degree of Bachelor of Science, from the College of Agriculture No. 202; Experiment Station contribution No. 301. Prepared in the Department of Animal Husbandry under the direction of Assistant Professor Valente Villegas.

Time and place

In conducting the survey part of the work, the writer made trips to San Pedro Tunasan, Santa Cruz, and Lumbang, in Laguna Province, and Meycawayan in Bulacan Province. The laboratory part of the work was performed by the writer at the College of Agriculture. The determination of the chemical constituents of the different classes of soft cheese was made in the Analytical Laboratory of the same College. The work was started in June, 1923, and closed in February, 1924.

MATERIALS

In performing the laboratory part of the work on soft cheese making the writer made use of the following:

1. Milk of cattle, including that of the native, Nellore, and Nellore-native cross; and of the native carabaos and Indian buffaloes.
2. Curdling materials consisting of the abomasum, or true stomach of carabao and cattle, Danish Hansen's rennet extract, and vinegar.
3. Salt.
4. Flavoring materials, such as pimentos, or Spanish red pepper and the small wild red pepper, *siling pacite* (*Capsicum frutescens*).
5. A cheese press for making Cebu cheese.
6. Sieves, pails, spoons, pans, strainers, banana sheaths and leaves, and tieing materials.

Preparation of abomasum and rennet extract

In the abomasum, or true stomach of the ruminant is contained the enzyme rennin, which brings about the curdling of the casein of milk in the making of cheese. So in the making of most cheeses the abomasum is prepared, from which rennet extract is derived and used for curdling the milk.

Many native cheese makers claim that abomasum from male calves two or three years old produces a stronger curdling action than that from the females. It is also claimed that calves less than three days old furnish abomasum of inferior curdling quality.

Santa Cruz and Lumbang, Laguna method. The Santa Cruz and Lumbang rennet extract is prepared by cutting a piece of abomasum, say 10 centimeters square, from a whole piece which has been dried. The abomasum is placed in a receptacle containing a little milk. If the stomach contains rennin, curdling takes place in a few hours. The serum, or whey that is formed, is filtered and the filtrate is known as the rennet extract. To curdle the milk that is to be made into cheese a certain amount of the extract is placed in it. After sufficient curdling has taken place the whey is decanted and part of it is recovered and placed with the abomasum previously used. This whey is used repeatedly until the liquid will no longer curdle. Usually a piece of abomasum may be used from five to seven days before its curdling effect is lost.

San Pedro Tunasan, Laguna method. In San Pedro Tunasan there are two methods followed in making rennet extract. One is identical with that employed in Santa Cruz and Lumbang, while the other is strictly local. In this method a piece of abomasum, about eight centimeters by two centimeters, is placed in a jar or pitcher containing a certain amount of warm water instead of fresh milk.

The preparation is usually made in the afternoon or the night before the day it is to be used. A part of the liquid is used to curdle the milk, and the rest is left in the container to macerate further the abomasum. In this way a certain amount of rennet extract is maintained until the abomasum is no longer strong enough to curdle the milk.

Cebu method. Cebu cheese makers use the abomasum from carabaos instead of from cattle. They use vinegar instead of milk or water. To extract rennin a piece of the abomasum is cut off and placed in a jar or cup containing vinegar as the extracting medium. The abomasum is immersed in vinegar for at least 12 hours before the extract is used.

In Meycawayan, Bulacan, vinegar alone is used to curdle the milk.

METHODS OF MANUFACTURE

Santa Cruz and Lumbang cheese. The manufacture of Santa Cruz and Lumbang cheese is about the same and so may be discussed together. The differences in the methods are of insignificant character, such as the time set for curdling the milk and the manner of wrapping and tieing the product. Another minor difference is the kind of molds used.

In the manufacture of the Santa Cruz cheese it is important that all necessary materials be made ready and that there be scrupulous cleanliness of hands, milk, and utensils. The cheese maker starts his work in the morning by straining the milk into pails or pitchers as it comes from the different patrons. The milk-rennet extract is poured into the milk gradually, stirring it all the while to distribute the rennin uniformly. The amount of rennet extract to be used depends on its strength, which varies according to the size and freshness of the abomasum, and also on the dilution of the extract. Cheese makers determine the amount by experience; they tell by the nature of the curd produced and the time necessary to produce it; much less of a strong solution effecting immediate curdling will be added than of a more diluted extract. Generally, with the ordinary rennet extract, it takes from 15 to 30 minutes to curdle the milk. As soon as thorough and complete curdling has taken place, which is easily recognized by the separation of a clear liquid, or whey from the curd, the curd is cut into squares by means of a knife or flat stick. It is then drained well in a bamboo sieve. Part of the whey passing through is saved and put into the container holding the abomasum, to be used the next day. The curd is then put into another container, usually a pail, and crumbled with the hand and salted to taste. The crumbling and mixing is continued for about 10 or 15 minutes, until the whole mass is very fine and of a smooth texture. A little more salt than taste requires is added as some will be washed away by the whey when the curd is in the mold. The treated curd is placed in molds of wood or banana leaves, the size depending upon market requirements. The usual size is 10 centimeters long by 10 centimeters wide and 2 centimeters thick, but larger ones are made for special trade. Wilted banana leaves are used to wrap each mold of cheese. In the market, pieces of cheese packed separately are usually wrapped together in tiers of three with more banana leaves and finally with banana sheaths. The leaves of the Saba variety of banana are used as they are tough and do not tear easily. The cheese made in the morning will be hard enough to be used on the table the next day.

The San Pedro Tunasan cheese. Except in the preparation of one of the two kinds of rennet extracts used, San Pedro Tunasan cheese is made by the same method as the Santa Cruz and Lumbang. These three towns are in Laguna Province.

Meycawayan cheese. In the making of Meycawayan, Bulacan, cheese the following materials and utensils are necessary: Fresh milk, vinegar, brine, bamboo tube with perforated base, and piston.

After straining the fresh milk it is heated almost to boiling and then carefully and slowly poured into a pail containing vinegar, stirring the mixture at the same time. Curdling follows immediately. If the whey appears cloudy, more vinegar may be added to effect complete curdling of the casein. The curd obtained is pressed between the hands to squeeze out the whey and then placed in a bamboo tube. In the tube the curd is pressed by the piston to remove as much liquid as possible. The resulting round cakes of cheese are then put into a vessel containing brine, which serves to preserve the cheese for a long time. This is probably the cheese described by Dovey (1913).

Cebu cheese. The process of making Cebu cheese differs not only in the preparation of the curdling extract, but in other respects, from any one of the three kinds just described. One difference is that a special press is used that squeezes the cheese so dry that it will keep long without immersing it in brine or other preservative.

In making Cebu cheese fresh carabao milk is used. After straining the milk rennet extract is poured into it, the amount depending on its strength. The curd is afterwards sliced and pressed through a bamboo sieve. Salt is then added to the curd and the whole mass stirred by means of a stick to secure uniform distribution of the salt. When the curd is fairly smooth in texture it is put into wooden molds lined with *sinamay* cloth. The molds are then placed under the cheese press and pressure applied gradually for twenty-four hours or until no whey can be squeezed out of the cheese slabs. After twenty-four hours the pressure is removed and the cheese slabs are taken out of the molds. Cebu cheese is a harder kind of soft cheese.

Pimento cheese. Pimento cheese is a very popular soft cheese. In its manufacture the Neufchatel cheese is used as the basic material. The writer included this cheese in this work as it is very well liked in the College of Agriculture by those who have acquired a taste for it. It is also of interest to cheese makers because the flavor is quite different from the Philippine soft cheeses.

In the making of pimento cheese the reader is referred for complete directions to Circular No. 38 of the Iowa Agricultural Experiment Station.

PRODUCTION AND PROFIT

In making this survey, the production and returns accruing from the manufacture of the different kinds of soft cheese, except the Cebu, were determined.

In looking over table 1 it may be noted that with all the cheeses studied, there was a profit in the undertaking. In the manufacture of Santa Cruz cheese, five cheese manufacturers were investigated. The profit in their operations over the cost of the raw material ranged from ₱3.45 to ₱6.00 a day depending to a large extent on the amount of milk used. On a liter of milk used the profit ranged from five centavos to twenty-three centavos. The amount and cost of milk used were different in each case, and the selling prices of the products were also different. The range in the price of milk used was from 21 centavos to 50 centavos a liter with an average cost of 30 centavos. The most common size of cheese made is the 50-centavo package of three pieces; packages selling for 5, 10, 20, and 50 centavos and at one peso are also put up. The small sizes up to, and including, the 20-centavo cakes and the 50-centavo packages, are made to supply the retail trade while the larger cakes are made to fill special orders.

TABLE 1

Showing production and return of native cheese manufacture

LOCALITY	CHEESE MAKER	MILK USED				PRODUCTION								PROFIT	PROFIT PER LITER OF MILK USED
		Amount	Cost per liter	Average cost per liter	Total cost	5-centavo cake	8-centavo cake	10-centavo cake	20-centavo cake	50-centavo cake	Peso cake	50-cvo. pkg. of 3 cakes	Total cost		
		liters	*centavos*	*centavos*	*pesos*								*pesos*	*pesos*	*centavos*
Santa Cruz	A	67.5	27	30	18.23					20		25	22.50	4.27	6
	B	15.0	50		7.50				5			20	11.00	3.50	23
	C	75.0	21		15.75				10	8		30	21.00	5.25	7
	D	75.0	27		20.25				11	8		35	23.70	3.45	5
	E	90.0	25		22.50	10		15	20	10	5	25	28.50	6.00	7
Lumbang	A	14.5	21	22	3.05		82	23	10				10.86	7.81	54
	B	26.3	21		5.52					22	5		16.00	10.48	40
	C	22.5	24		5.40	50		30			5		10.50	5.10	23
San Pedro Tunasan	A	11.0	29	28	3.19				20	5			6.50	3.31	30
	B	19.3	29		5.60				10	4		20	14.00	8.40	44
	C	16.5	25		4.13			20	5			10	8.00	3.87	23
Meycawayan, Bulacan	A	8.0	13	14	1.04	5		5	10				2.75	1.71	21
	B	22.5	13		2.93		10	15	20				6.30	3.37	15
	C	30.0	16		4.80	10	5	25	30				9.40	4.60	15

The profit over the cost of the milk of three cheese makers of Lumbang, as shown in table 1, ranged from ₱5.10 to ₱10.48 a day depending largely on the amount of milk used. On the basis of one liter of milk used the range in profit was from twenty-three centavos to fifty-four centavos. There was but a slight difference in the cost of the milk used; it varied from 21 to 24 centavos a liter, or an average cost of 22 centavos. It may be noted in the table that the smaller cakes are the most common size put up.

The profits of three cheese makers of San Pedro Tunasan ranged from ₱3.31 to ₱8.40 a day depending largely on the amount of milk used. The profits per liter of milk used ranged from 23 to 44 centavos. The average cost of milk a liter was 28 centavos, the cost varying from 25 to 29 centavos. The most common sizes of cheeses produced by these cheese makers are the 10 and 20 centavo cakes. A few 50 centavo cakes and 50 centavo packages containing three cakes in the package are also produced.

Three cheese makers were interviewed at Meycawayan, Bulacan. According to table 1, the profits accruing from their operations ranged from ₱1.71 to ₱4.60 a day. On the basis of one liter of milk used the profits were from 15 to 21 centavos. The average cost of a liter was 14 centavos, the range in price being 13 to 16 centavos. The cheese put out at Meycawayan is in 5, 8, 10, and 20 centavo cakes.

The writer made no attempt to weigh the different sizes of cheese cakes studied, inasmuch as different cheese makers, or even the same individuals, change the size and form sold at a certain price from time to time, the market demand apparently being the important factor governing this matter.

MARKETING

The marketing of Santa Cruz and Lumbang, San Pedro Tunasan, and Meycawayan cheese is simple, and is handled mainly by middlemen. This is particularly true of the Santa Cruz and the Meycawayan cheese which is immediately turned over to middlemen, who sell it in the market. The Santa Cruz cheese is retailed by middlemen, principally at the Santa Cruz and Calamba railroad stations in Laguna Province. A part of the product is taken to neighboring towns and sold directly to families at their residences. The Meycawayan cheese is sold also at the railroad station and at the market place of Meycawayan; part is sold to *bibinca*[2] makers of Manila. The San Pedro Tunasan cheese is sold by the makers themselves at the San Pedro Tunasan railroad station in Laguna. The Lumbang cheese is sent out to distant towns to be sold directly to consumers and to middlemen. The larger cakes of all the different kinds of cheese go directly to those who have ordered them.

EXPERIMENTAL

Supplementary to the survey of the making of native soft cheeses, the writer conducted experiments following the local methods. The tests were made with the following main objects in view:

(*a*) To acquaint the writer with the methods in practice so as to enable him to suggest possible improvements; (*b*) To determine the actual production resulting from the different processes of native cheese manufacture.

[2] *Bibinca* is a native cake made of rice flour, coconut, and other ingredients.

Santa Cruz and Lumbang method. Two sets of experiments were conducted in which the general procedure in the making of Santa Cruz and Lumbang cheese was followed. In one, the common abomasum to produce the rennet extract was used, while in the other, Hansen's Danish rennet extract was used to curdle the milk. The quantity of abomasum used and the amount of milk used to extract its rennin are the same as used in the native method. In the tests in which Danish Hansen's rennet extract was used, directions given by the laboratory putting out the extract as to the amount of this preparation, its dilution, and the temperature of the milk when the rennet extract was added were followed. As may be seen in table 2-A, recording production in which the native rennet extract was used, the average production of the seven tests carried out was 334 grams of cheese per liter of milk used, ranging from a minimum production of 300 to a maximum production of 406 grams.

TABLE 2-A

Showing production in the making of Santa Cruz and Lumbang cheese using native rennet extract

DATE	AMOUNT OF MILK USED	CHEESE PRODUCED	
		Weight	Weight per liter of milk used
1923	*liters*	*grams*	*grams*
July 1	2.0	600	300
July 8	2.0	610	305
July 14	2.0	600	300
Sept. 15	1.5	609	406
Sept. 22	2.5	850	340
Sept. 22	2.5	852	341
Dec. 20	4.0	1390	348
Total	16.5		Av. 334

With the sixteen tests made, in which Danish Hansen's rennet extract was used, the range of production was from 212 to 450 grams of cheese per liter of milk used. The average of the sixteen tests is 338 grams per liter of milk used. The figures obtained indicate that the production is about the same in both sets of experiments with an insignificant difference of eight grams in favor of the method in which Hansen's Danish rennet extract was employed.

TABLE 2-B

Showing production in the making of Santa Cruz and Lumbang cheese using Danish Hansen's rennet extract

DATE	AMOUNT OF MILK USED	CHEESE PRODUCED	
		Weight	Weight per liter of milk used
1923	*liters*	*grams*	*grams*
Sept. 30	1.5	590	393
Oct. 31	2.0	565	283
Nov. 11	4.0	846	212
Nov. 18	1.0	270	270
Nov. 18	1.0	425	425
Dec. 2	1.0	450	450
Dec. 8	1.5	482	320
Dec. 18	4.0	1385	346
Dec. 18	4.0	1275	319
Dec. 21	4.0	1351	338
Dec. 22	3.0	1205	401
Dec. 24	5.0	1508	301
Dec. 25	8.0	2450	306
1924			
Jan. 20	8.0	3211	401
Feb. 20	4.0	1450	363
Feb. 21	4.0	1385	346
Total	56.0		Av. 342

San Pedro Tunasan method. Six tests were run in which the San Pedro Tunasan method was used. As shown in table 3 the production varied a great deal, ranging from 350 to 520 grams of cheese per liter of milk used, the average being 421 grams.

TABLE 3

Showing production in the making of San Pedro Tunasan cheese

DATE	AMOUNT OF MILK USED	CHEESE PRODUCED	
		Weight	Weight per liter of milk used
1923	*liters*	*grams*	*grams*
July 29	.6	210	350
Aug. 5	.6	212	353
Sept. 7	1.2	540	450
Sept. 15	1.2	545	454
Sept. 30	1.5	780	520
Nov. 4	0.9	359	399
Total	6.0		Av. 421

Meycawayan method. Six tests of this method were run. Table 4 shows that the range of production was from 556 to 584 grams, or an average of 572 grams per liter of milk used.

TABLE 4

Showing production in the making of Meycawayan cheese

DATE	AMOUNT OF MILK USED	CHEESE PRODUCED	
		Weight	Weight per liter of milk used
1923	*liters*	*grams*	*grams*
Sept. 23	0.5	289	578
Sept. 30	0.5	278	556
Dec. 2	0.5	281	562
Dec. 2	0.5	290	580
Dec. 6	0.5	292	584
Dec. 6	0.5	285	570
Total	3.0		Av. 572

Cebu method. In the preparation of this cheese, five tests were made, the range of production being from 238.7 to 298.6 grams, or an average of 257.5 grams per liter of milk used.

TABLE 5

Showing production in the making of Cebu cheese

DATE	AMOUNT OF MILK USED	CHEESE PRODUCED	
		Weight	Weight per liter of milk used
1923	*liters*	*grams*	*grams*
Dec. 19	1.5	390.9	261.0
Dec. 23	4.0	954.7	238.7
Dec. 24	5.0	1225.7	245.1
1924			
Jan. 27	3.0	895.8	298.6
Feb. 16	4.5	1097.8	244.0
Total	18.0		Av. 257.5

Pimento cheese. In the preparation of this cheese eight tests were conducted. In carrying out these tests the method given by Brown and Mortensen (1919) was modified. The milk was allowed to curdle by the lactic acid it produced upon souring. Salt and pimento were added to the curd. The production obtained, as may be seen in table 6, ranged from 206 to 463 grams, or an average of 323 grams per liter of milk used.

TABLE 6

Showing production in the making of Pimento cheese

DATE	AMOUNT OF MILK USED	CHEESE PRODUCED	
		Weight	Weight per liter of milk used
1923	*liters*	*grams*	*grams*
Nov. 16	3.5	1015	290
Nov. 21	8.0	2116	265
Nov. 28	2.0	920	460
Nov. 28	8.0	2114	264
Dec. 5	5.0	1031	206
Dec. 18	12.0	4163	347
Dec. 20	3.5	1012	288
Dec. 24	2.0	925	463
Total	44.0		Av. 323

Summary. The records of production just discussed show that the greatest production was by the Meycawayan method which was 572 grams per liter of milk used, the lowest, 257 grams being shown in the preparation of the Cebu cheese. Similar quantities were obtained in the preparation of the other classes of cheese, such as the Santa Cruz and Lumbang and the pimento cheese. San Pedro Tunasan was intermediate.

CHEMICAL COMPOSITION

The results of the chemical analysis of the different classes of cheese conducted at the Analytical Laboratory, College of Agriculture are presented in table 7.

TABLE 7

Average chemical composition of soft cheeses. Analyses by the Department of Chemistry, College of Agriculture

KIND	WHERE MADE	NO. OF SAMPLES	MOISTURE	ASH	BUTTER FAT	REDUCING SUGARS	CASEIN (BY DIFFERENCE)	NaCl	ACIDITY EXPRESSED IN CC. 0.1N. NaOH PER 100 GRAMS SAMPLE
Santa Cruz	College	9	54.24	4.35	26.16	1.95	13.30	2.42	13.08
Santa Cruz	Santa Cruz	1	51.83	4.52	29.10	—	—	2.24	—
S. Pedro Tunasan	College	5	53.95	3.47	26.13	1.35	15.10	2.03	41.05
S. Pedro Tunasan	S. Pedro Tunasan	1	60.10	6.54	20.41	4.50	8.45	3.99	16.60
Meycawayan	College	2	66.61	3.45	18.70	1.70	9.54	2.41	40.09
Meycawayan	Meycawayan	1	51.85	7.77	24.09	0.01	16.28	5.96	21.61
Cebu	College	2	47.35	3.42	28.85	1.62	18.76	1.66	33.32
Cebu	Cebu	1	24.12	4.32	11.25	0.09	60.31	2.03	78.00
Pimento	College	3	62.83	2.55	15.70	1.96	16.96	1.62	74.92

Santa Cruz and Lumbang cheese. Nine samples of this kind of cheese made at the College of Agriculture and one sample made at Santa Cruz were submitted for analysis. Table 7 shows that the average moisture content of the samples made at the College was 54.24 per cent; ash, 4.35 per cent; butter fat, 26.16 per cent; sodium chloride, 2.42 per cent. The rest of the samples was made up mainly of casein and a small amount of reducing sugar. Only five of the samples were analyzed for other constituents, as: casein, 13.30 per cent; reducing sugar, 1.95 per cent; acidity, 13.08 cubic centimeters per 100 grams weight of cheese. It may be noted in the same table that there was but a slight variation between the cheese made at the College and that made at Santa Cruz.

San Pedro Tunasan cheese. The analysis of five samples of cheese made according to the San Pedro Tunasan method at the College of Agriculture shows the following averages (see table 7): Moisture, 53.95 per cent; ash, 3.47 per cent; butter fat, 26.13 per cent; reducing sugar, 1.35 per cent; casein, 15 10 per cent; sodium chloride, 2.03 per cent; acidity, 41.05 cubic centimeters per 100 grams of cheese. Comparing these averages with the analysis of cheese made at San Pedro Tunasan given in the same table, it may be observed that the moisture, ash, and reducing sugar contents of the cheese made at San Pedro Tunasan were high, while the butter fat and casein and acidity were low.

Meycawayan cheese. Two samples of Meycawayan cheese made at the College of Agriculture were submitted for analysis. The averages of the analysis (see table 7) were as follows: moisture, 66.61 per cent; ash, 3.45 per cent; butter fat, 18.70 per cent; reducing sugar, 1.70 per cent; casein, 9.54 per cent; sodium chloride, 2.41 per cent; and acidity, 40.09 cubic centimeters per 100 grams of cheese. Comparing these figures with the analysis of cheese made at Meycawayan it will be seen that there is considerable difference in the composition. The analysis of the cheese made in Meycawayan is very similar to that presented by Dovey (1913).

Cebu cheese. Two samples of cheese made at the College of Agriculture according to the Cebu method were submitted for analysis. The averages of the analysis (see table 7) are as follows: moisture, 47.35 per cent; ash, 3.42 per cent; butter fat, 28.85 per cent; reducing sugar, 1.62 per cent; casein, 18.76 per cent; sodium chloride, 1.66 per cent; and acidity, 33.32 cubic centimeters per 100 grams of cheese. Comparing these figures with the analysis of a piece of cheese at least two weeks old made in Cebu, it may be seen that the College made cheese is poorer in dry matter and casein and richer in butter fat. This was probably due in large measure to inadequate pressing of the cheese made locally.

Pimento cheese. Four samples of pimento cheese made at the College of Agriculture were submitted for analysis and the following averages were obtained (see table 7): moisture, 62.83 per cent; ash, 2.55 per cent; butter fat, 15.70 per cent; reducing sugar, 1.96 per cent; casein, 16.96 per cent; sodium chloride, 1.62 per cent; and acidity, 74.92 cubic centimeters per 100 grams of cheese.

In looking over table 7, it will be observed that the Meycawayan, pimento, and Santa Cruz cheese made at the College topped in moisture content, amounting to 66.61 per cent, 62.83 per cent, and 54.24 per cent, respectively. The lowest amount of moisture was shown by the Cebu cheese, amounting to 24.12 per cent. The Santa Cruz and Meycawayan cheese obtained from corresponding localities of manufacture were almost identical in moisture content, or

51.83 per cent and 51.85 per cent, respectively. The San Pedro Tunasan cheese made at the College had a moisture content of 53.95 per cent.

In regard to the butter fat content, it will be seen from the same table that the richest cheeses were the Santa Cruz cheese made at Santa Cruz, containing 29.10 per cent of fat, and Cebu cheese, having 28.85 per cent of fat. The pimento and Meycawayan cheese made at the College had low butter fat content, amounting to 15.70 per cent and 18.70 per cent, respectively. The San Pedro Tunasan cheese from San Pedro Tunasan tested a little higher in butter fat, or 20.41 per cent. The Meycawayan cheese made at Meycawayan had 24.09 per cent of fat, while the Santa Cruz and S. Pedro Tunasan cheese made at the College were almost identical in butter fat content, or 26.16 per cent and 26.13 per cent, respectively.

The acidity of the different kinds of cheese, as may be seen in table 7, varied from 13.08 cubic centimeters per 100 grams of the sample, in the case of the Santa Cruz cheese made at the College, to 78.00 cubic centimeters per 100 grams of the sample, in the case of Cebu cheese made at Cebu. The acidity of the San Pedro Tunasan and Meycawayan cheese made at corresponding places of manufacture were 16.60 cubic centimeters and 21.61 cubic centimeters per 100 grams of the sample. The Cebu cheese made at the College gave an acidity of 33.32 cubic centimeters per 100 grams of the sample. The Meycawayan and San Pedro Tunasan cheese made at the College had almost the same acidity, or 40.09 cubic centimeters and 41.05 cubic centimeters per 100 grams of the sample.

SUMMARY AND CONCLUSIONS

1. The methods of making soft cheese in Santa Cruz, Lumbang, and San Pedro Tunasan, Laguna Province, are more or less similar, while methods followed in Meycawayan in Bulacan Province and in Cebu are quite different.

2. Of the different soft cheeses studied the average production per liter of milk is as follows: Santa Cruz and Lumbang, 334 grams; San Pedro Tunasan, 421 grams; Meycawayan, 572 grams; Cebu, 257 grams; and pimento, 323 grams.

3. The profits above the cost of milk in the industry of making of native soft cheeses are adequate and encouraging.

4. The retail sizes of the Santa Cruz and Lumbang, San Pedro Tunasan, and Meycawayan cheeses are as follows: 5 centavo, 8 centavo, 10 centavo, 20 centavo cakes and the 50 centavo package of three cakes. The 50 centavo and one peso cakes are put up only to fill special orders.

5. In the order named the following cheeses made in their particular localities have the greatest amount of water and therefore the least amount of dry matter: San Pedro Tunasan, Meycawayan, Santa Cruz, and Cebu cheese.

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POLLINATION AND THE FLOWER OF RICE[1]

PEDRO A. RODRIGO

WITH TWO PLATES AND ONE TEXT FIGURE

INTRODUCTION

It is universally believed that rice (*Oryza sativa* Linn.) is highly self-pollinized. Investigations carried out in Java, Burma, and in India, however, show that natural cross-pollination does exist in rice. In the Philippines, little is known about this phenomenon; no close study of the rice flower and its pollination has been undertaken. The question is of practical importance both to the plant breeder and to the farmer as the prevention of contamination of isolated pure lines depends a great deal upon their knowledge as to what extent natural cross-pollination in rice is possible. Again, knowledge of the special features of the rice flower during its dehiscence would be of great aid to the plant breeder in his work, especially in artificial cross-pollination.

Review of previous work

According to available literature which has a bearing on the subject, the first systematic study of the rice flower and its pollination was made within the last ten or fifteen years. Van Breda de Haan (1913), in his report of the results of Van der Stok's experiments in Buitenzorg, states that the rice flower actually opens. He says that when the flower opens, the glumes are set apart by the swelling of the "lodicules" which absorb water. After some time, the lodicules lose their water, thus they lose their turgidity and hence the flower is closed. He also says that under Buitenzorg conditions the opening of the rice flower takes place between 6:00 a. m. and 3:00 p. m. and has its maximum between 10:00 a. m. and 12:00 noon. Mr. Apostol of the Philippine Bureau of Agriculture is quoted in the *The Rice Journal* (1919) as stating that the rice flower opens only on sunny mornings between the approximate hours of 9:45 and 11:20, and that, in the course of five days, all the flowers in a panicle will have opened.

According to Thompstone (1915), the rice flower opens early in the morning, usually between 7:00 and 10:00 o'clock and most flowers open from about 8:00 to 9:00 o'clock. As the dew gradually disappears, the flowers open till the day begins to get dry and warm. The open flowers then close up and the stamens which are dried and shriveled by this time are excluded by the glumes. The glumes, when fully open, make an angle of from about 25° to 30°. Thompstone found that "pollination takes place before the glumes open, or at the moment of opening, seldom afterwards"; and according to Bhide (1914), the opening of the glumes and the bursting of the anthers take place more or less simultaneously.

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According to Van Breda de Haan (1913), an average of three minutes elapses from the opening of the glumes till the bursting of the anthers. This deviates from the observations of Thompstone and of Bhide and may be due to the different climatic conditions. Van Breda de Haan states that two minutes later, the stamens become dry and bend down. The flowers in the same panicle do not open at the same time; it takes from six to ten days for all the flowers in a panicle to open. This same authority further reported that natural cross-pollination occurs in rice. Gutierrez (1918) and Jacobson (1914) reported suspected natural hybrids in the Philippines. Mendiola (1922) of the Department of Agronomy of this College found a third case of natural hybrids in this country. From cultures of the variety Nagdami, an awnless variety, he discovered awned individuals. Seeds from these produced both awned and awnless plants. Similarly, from cultures of Putyucanon, which is an awned variety, he obtained seeds which produced both awned and awnless plants. Cases of natural hybrids have been observed, too, by Thompstone (1915) and McKerral (1913) in Burma, by Hector (1913) in Dacca, and by Parnell *et al* (1917) in Coimbatore.

The extent of natural cross-pollination was determined in Buitenzorg (1913) and it was found that of the plants which germinated from 585 panicles, there were only 52 panicles with one or more hybrids and the highest percentage of natural hybrids in one panicle was 25 per cent. In some panicles there were three, four, five, eight, and thirteen per cent of hybrids, but in the majority of cases, the percentage remained below one. The conclusion is that in spite of the favorable conditions for cross-pollination the number of hybrids was very small. From this experiment, it is evident that the rice pollen grains are not carried long distances. As cited by Van Breda de Haan (1913), Conner, who made a number of trials in the Philippines, considers a distance of one meter between rows of different varieties sufficient to prevent cross-pollination. Hector (1913) says that natural cross-pollination is confined only to neighboring plants, and that the pollen of one plant seldom, if ever, succeeds in reaching the stigma of a flower more than two feet (0.61 meter) away.

McKerral (1913) conducted a similar experiment in Burma, using a variety known to be a mixture of red and white Ngasein. He selected 100 heads each of red and white and planted them in separate plots. His experiment went as far as the study of the F_2 individuals and he found that the segregation of color followed Mendel's law and was in the ratio of three red to one white. According to Thompstone (1915), "the whiteness and redness of glumes act as a pair of simple Mendelian characters, the former being dominant. Whiteness and redness of grains also act as a pair of simple Mendelian characters, redness being dominant."

Mendiola (1919) reports, "that rice grains will develop even if the upper halves of the hulls are cut before pollination or even if the hulls are opened at this time and subsequently closed." In other words, the rice flower stands emasculation. "In the first case, the grain develops half naked. In the second case, it develops either with closed hulls or with hulls partly opened at the top." Mendiola used the same method as that followed by Van Breda de Haan, that is, of emasculating flowers which were to open on a certain day. The grains assumed the normal length but had to be protected from damage from the outside.

The present work

The objects of the present work were: (*a*) To study some features of the rice flower in connection with its pollination; and (*b*) To determine to what extent cross-pollination is possible.

The investigation was conducted in the College of Agriculture between June, 1920 and March, 1921. The review of literature in this paper is brought down to 1922.

MATERIALS AND METHODS

In this investigation, seven varieties of rice were used; namely, Binicol, Inintiw, Binangbang, Tadioc, Tanuco, Kariit, and Kinamaleg. The first three varieties were used in the study of the features of the flower related to its pollination while the last five were used in connection with both natural and artificial pollination. Binicol, Inintiw, Binangbang, Tanuco, Kariit, and Kinamaleg are awnless varieties, while Tadioc is an awned variety. All the varieties used were white hulled except Kinamaleg which is a red hulled variety.

With the exception of Tanuco and some cultures of Inintiw all the varieties used were cultured at the College by rice thesis students.

EXPERIMENTS AND RESULTS

Study of the flower and of pollination

For the study of the flower, three varieties; namely, Binicol, Inintiw, and Binangbang were used. The varieties Inintiw and Binangbang were grown under lowland conditions, and Binicol under upland conditions.

On September 5, 1920, the variety, Binicol began to flower and observation was commenced. Observation on variety, Inintiw was begun on October 10 and on Binangbang on October 21. The observations made consisted in the study of some special features of the flower in connection with its pollination; the determination of the transportation by wind of pollen grains; artificial culture of pollen; and in a study of the time and duration of the opening and dehiscence of the anthers. Tables 1, 2, 3, 4, 5, 6, 7, and 8 present the results of the observations made.

Table 1 shows the anthesis and the life of the flowers in a panicle.

Table 2 gives the comparative length of time in which the glumes open, that is, the duration from the time the glumes start to open until they are fully open and are closed again.

Table 3 contains the measurements of the opening of the glumes when fully open. The measurement as noted in table 3 was taken at the tips of the glumes when they were fully extended.

Table 4 gives the number of pollen grains that fell on the stigma just after the flower opened. To determine the number, the flower which had just opened was carefully bent down and the anthers removed with the aid of a pair of forceps. The flower was then detached from the panicle and the ovary was carefully removed with a dissecting needle. The ovary was placed on a glass slide and its stigmas (two in number) were examined under a low power microscope. The pollen grains were then counted.

Table 5 shows the approximate number of pollen grains in one anther and in a flower. The pollen grains in one anther were counted by taking a matured,

unopened anther and placing it on a glass slide and allowing its pollen grains to drop on a narrow strip. By counting the number of pollen grains from one end of the strip to the other, with the aid of a low power microscope, a very close approximation of the number of pollen grains in an anther was obtained. Anthers for this purpose were taken from different flowers. The number of pollen grains in a flower was found by multiplying the average number of grains per anther by six, as a flower has six anthers.

Table 6 gives the size of pollen as determined by the aid of an eye-piece micrometer. Matured pollen grains were mounted on a glass slide with water and were measured under a high-powered objective. The pollen grains were almost round so only one diameter was taken.

Table 7 shows the comparative distances of the flight of pollen. Pieces of glass (12×18 cm.) were used in catching pollen. The glass plates were coated with vaseline on one surface and were placed on strips of bamboo-parallels placed horizontally at about the height of the panicle, some flowers of which were then opening. The coated surface was divided into rectangles, two square centimeters in area. These coated plates of glass were, one day, placed at different distances as shown in table 7 on the parallels before the flowers opened and then were removed and examined with the aid of a microscope at about 11:30 a. m. that same day. The pollen grains that were caught on the glass were determined by counting them on four different spots each of which was two square centimeters in area.

Table 8 shows the time of opening of the flowers of three rice varieties. The observation with each variety, as shown in the table, was made at different times as the varieties in question did not flower at the same season.

Effort was made to germinate rice pollen artificially. The method used was that of Popenoe (1917) with slight modifications. On a glass slide a small rubber ring or glass ring was mounted, the edges of which were previously greased with vaseline to exclude air. A drop of the sterilized culture medium was placed on a cover glass and, with the aid of the forceps, pollen was sown upon the drop by touching it with a stamen at different places. The cover glass was then inverted over the ring. Different solutions (1 to 50 per cent) of cane sugar (refined, about 97 per cent purity) were tried. The same concentrations of solutions with the pollen placed on the stigma were also tried. The belief is that the substance necessary for the germination of pollen may be produced by the stigma, but the result was negative. The cultures were run in duplicate and were placed in closed moist wooden boxes under ordinary room temperature. It was found that in solutions of from 1 to 25 per cent, the pollen grains burst within a few minutes as they do in water and in solutions of more than 45 per cent concentration. In solutions of from 30 to 44 per cent concentration the pollen grains remained normal after 24 hours, but nothing was found to germinate after several trials.

Natural cross-pollination

Varieties, Tanuco and Inintiw were grown in petroleum cans. The cans were filled with ordinary garden soil. Ten cans were used and four hills were planted in each can. Each variety was represented in each can by two hills. They were grown under lowland conditions. The purpose of planting two varie-

ties in a can was to bag them together when they flowered so the possibility of natural cross-pollination might be determined. When the plants were about ten centimeters high they were thinned to one each hill.

The varieties were planted on such dates as would allow them to flower at practically the same time. But, unfortunately, Inintiw flowered earlier, so the writer was obliged to carry four of the pot cultures to a plot of another awned variety (Tadioc) which was then flowering.

On October 2, one plant each of Tadioc and Inintiw were bagged together. Eight plants of each variety were used. Because some rice bugs, *Leptocorisa acuta* Thumb., gained access into the bags, many of the grains did not develop, hence fewer seeds for planting were obtained. On November 5, the grains matured and were harvested, great care being taken to prevent the mixing of the seeds from the different plants. The harvested seeds were planted in pots; the seeds from one plant were planted separate from the rest. The plants were grown under lowland conditions. Table 9 shows the result of the experiment.

Artificial cross-pollination

A reciprocal cross was made between the varieties, Kariit and Kinamaleg. These varieties seem to be highly pure.

On October 13, ten plants of each of the varieties were selected for the female parents. Panicles, a large number of the flowers of which would open on that day, were selected for emasculation. Early in the morning, between 6:00 and 8:00 o'clock, the flowers were emasculated. Under Los Baños conditions, it is best to emasculate the rice flower early in the morning as the danger of selfing the flower by the bursting of the stamens when touched is less at this time. Also, emasculation may be done late in the afternoon and pollination in the following morning.

Emasculation consisted of the cutting off of the upper half portion of the glumes with a pair of small scissors followed by the removal of the anthers (six in number) with a pair of fine forceps[2]. About from 20 to 30 flowers in a panicle were emasculated and the rest were cut off. The emasculated flowers were bagged immediately with small paper bags, to be pollinated a few hours later. The emasculated flowers were pollinated by shaking a panicle above them, some flowers of which had just then opened. After pollination they were again bagged to prevent contamination by other pollen grains and to protect the exposed ovaries from injury from the outside. They remained bagged until they were harvested.

On November 13, the suspected hybrid seeds were harvested. Not all the emasculated flowers produced grains. The developed grains attained the normal length of the grain, but the upper portion was formed abnormally. Because of this, these suspected hybrids were germinated soon after harvesting. They were germinated in sterilized agar solution containing some nutrient solution which consisted of one part by volume each of a-molar solution of ammonium sulphate, $(NH_4)_2SO_4$, calcium nitrate, $Ca(NO_3)_2$, potassium acid phosphate, KH_2PO_4, and magnesium sulphate, $MgSO_4.7H_2O$. The grains were hulled and sterilized for five hours in a seven per cent solution of calcium oxychlorid,

[2] Method employed by Van der Stok in Buitenzorg and by Mendiola in the College of Agriculture, Los Baños.

$CaOCl_2$, before they were put in the germinating medium. Doctor Mendiola told the writer that ordinary rice grains, hulless, could remain in this solution for 48 hours without their vitality being injured. The agar solution was put in test tubes and these together with their contents were sterilized under 15 atmospheres of pressure. Not all the seeds germinated.

When the seedlings were about two centimeters high, they were pricked in a seed box filled with sterilized, sifted garden soil in order to allow them to have a good start of growth before they were transplanted to the permanent place. The utmost care was exercised so as not to mix the seedlings from the different mother plants. On November 20, the suspected bybrid seedlings were

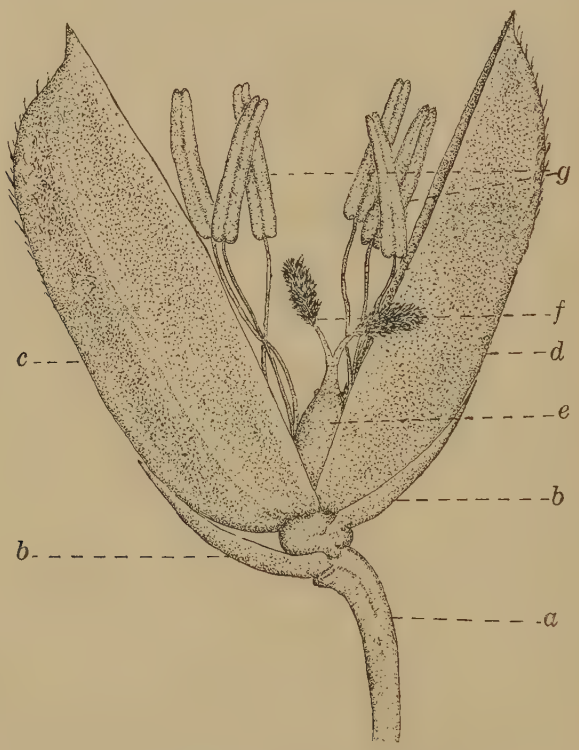

Fig. 1. The rice flower (spikelet), enlarged:
(*a*) peduncle; (*b*) empty glumes; (*c*) palea inferior;
(*d*) palea superior; (*e*) pistil; (*f*) stigma; (*g*) anthers.

transplanted to petroleum cans filled with garden soil. In all cases, check cultures consisting of plantings of non-hybridized grains from the mother plant were run. On January 20, the hybrids (F_1) began to flower; they were studied with respect to color of hull. Table 10 shows the results of the experiment.

DISCUSSION OF RESULTS

The flower and its pollination

Structure of the flower. As shown in figure 1, the rice flower has two outer glumes called the *empty glumes;* two inner glumes, the *palea inferior* and the *palea superior;* six stamens; and one ovary with two feathery stigmas. The rice flower as examined by the writer follows the description by Trelease (1919).

Anthesis and life of the flower. As will be discussed later, the individual flower opens and is pollinated on the same day. As shown in table 1, the flowers in a panicle generally begin to open one day after its first appearance. However, some flowers open on the same day in which the panicle first appears, provided it emerges out of the leaf sheath before midday, while a few open two days later. This is true of the three varieties studied. This information is important especially to the plant breeder for it suggests to him what flowers are ready for emasculation. The whole panicle under Los Baños conditions is out of the leaf sheath within two or three days, although a few panicles are out within a day and still others within four days, as with variety, Binangbang.

The flowers in a panicle do not open at the same time. They open from the top downward in a fairly regular sequence; all may open within from five to ten days after the first appearance of the panicle, the average being from six to seven days.

Opening and closing of the flower. The general conception of the Filipino farmer is that the rice flower opens in the night. The writer, however, found that it opens, generally, in the daytime, before midday. The time of opening as found under Los Baños conditions is, indeed, exceedingly variable; it ranges on sunny days from 8:00 a. m. to 12:00 at noon; and on rainy days, cases have been observed in which a few flowers opened as early as 6:00 a. m. and as late as 12:30 p. m. As shown in table 8, however, the opening generally takes place between 9:00 and 11:30 a. m., depending upon the atmospheric and climatic conditions. The different varieties do not seem to show any special characteristic which affects the time of opening.

The flower opens slowly. The time covered by the opening is, on an average, 6.7 minutes for Binicol; 6.5 minutes for Inintiw; and 6.9 minutes for Binangbang; the range in all cases being from 4 to 10 minutes. After the flower opens, the glumes fully open, the opening at the tips having an average width of 2.67 millimeters for Binicol; 2.57 millimeters for Inintiw; and 2.73 millimeters for Binangbang, as shown in table 3. At this stage the feathery stigmas can be seen protruding between the inner glumes till the flower closes when the stigmas are again encased inside.

The rice flower, as shown in table 2, remains actually open, on an average, 54.7 minutes on the Binicol; 48.0 minutes on Inintiw; and 55.0 minutes on Binangbang. The time ranges from 36 to 89 minutes with the Binicol; 36 to 83 minutes with the Inintiw; and from 41 to 72 minutes with the Binangbang. It is apparent that there was a wide variation among these varieties. It is to be borne in mind, however, that the observations were not made during the same season of the year. The variation may have been caused by the different climatic and atmospheric conditions, as was found by Hector (1913) in Dacca.

Pollination. The writer does not know positively just what elements bring about dehiscence. It was found that at the opening of the glumes, the stamens were touching the roof of the glumes. This is due to the rapid elongation of the filaments of the stamens. If, at this stage, the glumes are gently opened, the anthers dehisce and the stigmas below are showered with pollen. The sudden entrance of air into the glumes may be another element which brings about dehiscence. The fact that some anthers dehisce after the opening of the glumes

shows that the elements mentioned above are not the only ones which may bring about dehiscence.

As a result of the examination of the stigmas just after opening, the writer claims that in the majority of cases, dehiscence and pollination take place simultaneously with the opening of the flower. Cases, however, were observed in which dehiscence and pollination took place some time after the opening of the flower. Table 4 shows that just after the opening of the glumes, the number of pollen grains in the stigmas of one flower varies from 0 to 64 in the case of Binicol; 0 to 63 in the case of Inintiw; and 0 to 68 in the case of Binangbang. Out of the fifty flowers of Binicol, three flowers had their stigmas free from pollen; of Inintiw, four; and of Binangbang, two. This gives the idea that natural cross-pollination may exist in rice as the stigmas are by this time protruding between the glumes and may catch pollen of other plants. It is further shown in table 7 that pollen grains are carried by the wind in the same plane as the flower itself, as far as from 150 to 200 centimeters from the flower, varying according to the velocity of the wind. There is, therefore, every reason to believe that pollen of some flowers may alight upon the unpollinated stigmas of the flowers of other plants that are not more than 150 centimeters distant. In the case of the varieties studied, it may be said, too, that cross-pollination is impossible under Los Baños normal conditions, when there is at least a distance of two meters between the plants. This is of great significance to the farmers as the danger of natural crossing may be minimized, if not entirely avoided, by planting the plants at least two meters away from each other.

The pollen. Like wind-pollinated flowers, the rice flower produces a great number of pollen grains. The average number of pollen grains per stamen is 645 for Binicol; 641 for Inintiw; and 653 for Binangbang; the range running from 463 to 915. The writer does not claim that the counting was done with perfect accuracy as the instruments used for this purpose were, as a whole, crude. However, it was done with fair accuracy.

The pollen of the varieties studied is fairly round in shape, and yellowish white in color. When dry, it shrivels and becomes smaller and assumes several shapes. When mounted in water, it does not change in size and in shape, but a great many grains burst after a while. The pollen grains have an average diameter of from 43.65 to 44.48μ. The size varies considerably, the minimum and maximum diameters being 36.0 and 53.2μ, respectively. The difference in this respect between the varieties is almost negligible. It may be said that the variation in size of the pollen grains within a variety is as great as the variation of pollen grains within the varieties themselves.

As said elsewhere, attempts were made to grow pollen artificially. The writer was not able to germinate any pollen, but he found that pollen put in medium of from 30 to 45 per cent sugar solution remained normal in appearance and in shape after 24 hours.

Natural cross-pollination

Contrary to the widely accepted belief that the rice flower is self-pollinized, the writer found that natural cross-pollination in rice is possible. Table 9 confirms this supposition. Among the eight parent plants of Inintiw (awnless), it was found among 41 F_1 offspring that an awned individual was produced from parent plant No. 3. This particular parent has eleven offspring and one out of

these is awned. The percentage of hybrids as based on the number of plants from the same parental plant is 9 per cent; when based upon the total number of individuals, it is found to be 2.4 per cent. This result, however meager, agrees with the results of the work carried out by Hector in Dacca.

While, because of the small amount of seeds harvested and the low percentage of germination, the result seems meager, yet it shows that natural cross-pollination does exist in rice. In the case of the awned variety, Tadioc, no evidence of hybridity was expected out of the 58 F_1 plants that germinated, for awnlessness is recessive to presence of own. That there was hybrid among them remains to be determined in the test for F_2 plants.

Artificial cross-pollination

As stated under this topic in describing the experiment, the rice flower is able to stand emasculation even to the cutting off of the upper half portion of the glumes. The grain develops under such a condition, but is abnormally formed at the tip, yet is able to germinate with a comparatively high percentage in a certain sterilized agar solution containing some mineral nutrients.

As shown in table 10, the suspected hybrids vary in the color of the hull of the grains at the milk stage. Some are red, the majority are variegated red and white, and the rest are white. The red-hulled mother plants produced both red and white-hulled individuals, the latter having their hulls tinted with varying shades of red at both ends. The white-hulled mother plants produced white-hulled individuals, a few of which were entirely white-hulled and the rest tinted with red of varying shades at both ends of the grains and in some cases, at the veins of the inner glumes.

Because only red-hulled mother plants produced individuals that were red-hulled and only white-hulled mother plants produced white-hulled individuals, the writer can not at this stage of experimentation tell which color, "red" or "white", is dominant over the other. This can be determined only in the performance of these individuals in the second generation, as some, if not all, the red and white-hulled offspring are likely to be not hybrids. At the milk stage, however, neither the "red" nor the "white" color of the hull seems to be completely dominant over the other, because according to Mendel's law only one of the characters in pair is externally exhibited by the plant where there is a complete dominance of one character over another. Thompstone (1915) found that the "white" color of the hull is dominant over "red", but he did not state at what stage he made his observation.

It is further shown in table 10 that the suspected hybrids varied widely in the number of days to flowering. The offspring of six of the white-hulled mother plants flowered within 100 to 106 days, apparently earlier than the non-hybrid offspring from the same mother plant (check). While the offspring of the white-hulled mother plants flowered earlier than their checks, those of the red-hulled mother plants as a whole flowered later than their checks. Summing up, the hybrids of the reciprocal cross between Kinamaleg and Kariit have their pre-flowering period intermediate between the pre-flowering period of both parents.

SUMMARY OF CONCLUSIONS

1. Under Los Baños conditions, the flowers of varieties Binicol, Inintiw, and Binangbang were found to open and to be pollinated on the same day. They

remained actually open, on the average, from 48 to 55 minutes. The flowers opened in the forenoon, generally between 9:00 and 11:30 o'clock; very infrequently between 6:25 and 9:00 a. m. and between 11:30 a. m. and 12:30 p. m. It took the flowers about from six to seven minutes before the glumes were fully extended. The flowers in a panicle may all open within from five to ten days.

2. The dehiscence of the anther and pollination, in the majority of cases, took place simultaneously with the opening of the glumes on varieties, Binicol, Inintiw, and Binangbang; and in a few flowers the dehiscence and pollination took place after the opening.

3. Natural cross-pollination existed to a certain extent among the flowers of the plants which were bagged together. The extent of natural cross-pollination is estimated to be at least about 2.4 per cent.

4. An awned individual was found among the progeny of the variety, Inintiw (awnless) which was bagged with the variety, Tadioc (awned) during flowering.

5. The rice flower is able to stand emasculation. The hybrid seeds were deformed at the tip, but they germinated with high percentage in agar solution containing some nutrient solution.

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ILLUSTRATIONS

TEXT

Figure 1.—The rice flower (spikelet) showing the different parts, enlarged.

PLATE I

Figure 1.—Pistil and stamens (greatly enlarged).
Figure 2.—Pollen grains as seen under high power microscope.

PLATE II

Figure 1.—A branch of a rice panicle showing some developed hybrid seeds, partly covered.
Figure 2.—Hybrid seed, partly covered (greatly enlarged).
Figure 3.—Hybrid seed, with hull removed (greatly enlarged).

TABLE 1

Anthesis and life of the flowers in a panicle

PANICLE NUMBER	BINICOL			ININTIW			BINANGBANG		
	Length of time from first appearance till			Length of time from first appearance till			Length of time from first appearance till		
	first flower opens	whole panicle is out	all have opened	first flower opens	whole panicle is out	all have opened	first flower opens	whole panicle is out	all have opened
	days	*days*	*days*	*days*	*days*	*days*	*days*	*days*	*days*
1	1	2	7	1	3	8	1	3	8
2	1	2	7	1	2	7	1	3	7
3	1	2	7	1	3	8	2	3	7
4	1	3	6	1	2	7	1	2	5
5	1	2	7	1	2	9	2	3	6
6	2	3	5	1	2	7	1	3	5
7	1	3	6	1	2	7	2	3	8
8	1	2	8	1	2	7	1	3	6
9	1	3	8	1	2	7	1	3	8
10	0	2	9	1	2	7	1	2	7
11	1	2	6	0	2	7	2	3	9
12	1	2	6	1	2	6	2	4	7
13	1	2	7	1	2	7	1	3	7
14	1	2	7	1	3	7	1	2	6
15	2	4	6	1	2	7	1	2	4
16	1	2	5	1	2	7	2	3	7
17	1	3	5	1	2	6	1	3	6
18	1	3	9	1	2	6	1	2	6
19	1	2	6	1	2	7	1	3	7
20	1	2	7	2	2	8	1	2	5
21	1	3	7	2	3	8	1	3	8
22	1	3	6	1	2	8	1	3	6
23	1	2	5	1	3	8	1	2	7
24	0	3	5	1	2	5	1	4	7
25	0	1	5	1	2	9	1	3	6
26	1	2	7	1	2	7	2	2	5
27	0	2	7	1	2	7	1	3	8
28	1	3	9	1	2	6	1	4	6
29	1	2	6	1	2	6	1	3	7
30	1	3	8	1	2	6	1	3	6
31	1	3	6	1	2	7	0	2	7
32	1	2	8	1	2	7	1	1	6
33	1	3	8	1	3	8	1	3	6
34	0	2	6	1	2	7	1	2	6
35	1	3	7	1	2	6	1	3	5
36	1	3	7	1	3	7	1	3	9
37	2	3	9	1	3	7	1	3	8
38	1	3	6	1	2	7	1	3	8
39	1	1	6	1	2	7	1	2	7
40	1	2	9	1	3	7	1	3	7
41	1	3	5	1	2	6	1	2	6
42	1	3	7	1	3	7	0	2	8
43	0	2	8	1	4	6	1	3	8
44	1	3	6	2	2	7	1	3	8
45	0	2	7	1	2	7	0	2	5
46	1	3	7	1	2	6	1	2	5
47	1	2	8	1	2	7	1	2	7
48	1	1	7	0	2	6	1	3	8
49	1	3	7	1	2	6	2	4	9
50	1	2	10	1	2	7	1	3	7
Av.....	0.9	3.5	6.9	1.0	2.2	6.9	1.1	2.7	6.5

TABLE 2

Comparative length of time for the opening of the glumes

FLOWER NUMBER	BINICOL		ININTIW		BINANGBANG	
	Length of time		Length of time		Length of time	
	Beginning till fully opened	Beginning till closed	Beginning till fully opened	Beginning till closed	Beginning till fully opened	Beginning till closed
	min.	*min.*	*min.*	*min.*	*min.*	*min.*
1	7	47	6	51	8	49
2	8	45	6	50	5	51
3	8	41	5	50	5	56
4	8	46	6	51	10	41
5	8	50	9	56	9	46
6	10	52	8	58	5	48
7	9	49	9	50	8	53
8	7	45	9	43	10	55
9	8	43	7	45	8	49
10	9	45	5	43	9	53
11	9	46	6	83	7	51
12	7	47	5	45	5	48
13	7	50	10	41	8	53
14	7	50	6	47	7	47
15	7	48	7	61	7	50
16	5	49	7	67	10	55
17	4	68	7	41	7	52
18	6	57	6	44	7	62
19	7	72	7	36	6	49
20	6	64	6	50	7	51
21	9	60	9	46	6	51
22	10	52	6	38	7	51
23	9	52	4	38	9	50
24	10	60	6	51	10	49
25	5	55	6	45	6	47
26	5	63	5	47	7	47
27	6	62	6	51	8	50
28	6	52	7	47	4	54
29	5	50	4	38	7	57
30	6	52	5	39	6	63
31	7	55	4	43	8	52
32	6	59	7	38	6	55
33	9	36	7	37	7	63
34	9	45	5	71	6	61
35	5	51	6	64	8	66
36	4	39	7	63	8	64
37	5	52	5	53	6	59
38	6	44	6	44	9	62
39	4	44	8	44	5	57
40	5	51	5	39	6	61
41	6	51	9	40	9	72
42	6	89	5	49	7	68
43	6	48	6	52	6	67
44	7	54	7	47	8	58
45	6	57	8	38	6	55
46	6	55	7	40	6	62
47	6	60	6	50	6	70
48	5	64	8	43	4	55
49	4	44	6	41	6	61
50	5	68	9	51	8	43
Av....	6.7	54.7	6.5	49.9	6.9	55.0

TABLE 3

Measurement of the opening of the glumes when fully opened[a]

FLOWER NUMBER	BINICOL	ININTIW	BINANGBANG
	Width	Width	Width
	mm.	*mm.*	*mm.*
1	2.5	2.5	3.0
2	3.0	2.3	2.5
3	2.8	2.3	2.7
4	3.0	3.0	2.7
5	2.8	2.5	3.2
6	2.5	2.8	2.7
7	3.2	2.5	3.0
8	3.4	2.3	2.3
9	3.1	2.9	2.3
10	2.9	3.0	3.1
11	2.9	2.5	2.9
12	2.6	2.4	2.5
13	3.0	2.9	2.5
14	2.7	2.3	2.4
15	2.7	3.1	3.1
16	2.8	2.7	2.6
17	2.5	2.6	2.3
18	2.6	3.0	2.8
19	2.1	2.9	2.9
20	2.5	2.8	3.0
21	2.7	2.7	3.1
22	2.9	2.5	2.4
23	2.7	2.7	2.7
24	2.8	2.8	2.6
25	2.5	2.7	2.4
26	2.5	2.1	2.5
27	2.7	2.4	2.8
28	2.8	3.0	3.2
29	2.7	2.2	2.9
30	2.2	2.6	3.6
31	2.6	2.1	2.5
32	2.9	2.3	3.4
33	3.0	2.2	2.9
34	3.1	3.2	3.1
35	3.0	2.1	2.8
36	2.5	2.5	2.7
37	2.5	2.4	2.5
38	2.6	2.7	2.3
39	2.4	2.5	2.6
40	2.2	2.0	2.7
41	2.7	2.5	2.5
42	2.4	2.5	2.4
43	2.3	2.4	2.5
44	2.6	2.5	2.8
45	2.7	2.3	2.9
46	2.3	2.9	2.6
47	2.4	2.2	3.0
48	2.3	2.5	2.9
49	2.4	2.6	2.8
50	2.5	2.9	2.1
Av....	2.67	2.57	2.73

[a] Measurement was taken at the tips of the glumes when they were fully opened.

TABLE 4

Number of pollen grains that fell on the stigma just after the flower opened

FLOWER NUMBER	BINICOL	ININTIW	BINANGBANG
1	37	15	13
2	34	28	13
3	54	34	7
4	53	30	4
5	0	63	31
6	2	29	1
7	42	20	0
8	19	0	37
9	38	19	33
10	22	42	8
11	2	44	11
12	59	10	4
13	21	8	3
14	10	3	25
15	35	33	16
16	29	13	23
17	8	11	5
18	1	6	21
19	24	46	2
20	26	31	68
21	10	5	22
22	5	1	27
23	2	4	54
24	46	23	38
25	38	32	50
26	5	4	27
27	8	12	6
28	13	0	12
29	29	2	34
30	19	34	49
31	23	54	37
32	18	21	18
33	8	11	38
34	6	29	16
35	9	23	22
36	4	4	9
37	6	6	2
38	10	29	11
39	3	35	19
40	10	0	0
41	0	20	17
42	1	19	5
43	19	0	27
44	0	26	3
45	64	39	29
46	9	41	43
47	13	28	17
48	2	13	12
49	11	56	25
50	7	24	19
Av.....	18.0	21.6	20.2

TABLE 5

Number of pollen grains in one anther

ANTHER NUMBER	BINICOL	ININTIW	BINANGBANG
1	722	754	676
2	537	691	557
3	664	486	611
4	648	614	894
5	705	463	602
6	497	635	533
7	671	620	558
8	744	683	631
9	699	559	640
10	663	763	489
11	658	740	915
12	591	585	719
13	803	612	587
14	519	682	666
15	633	555	705
16	715	663	683
17	488	711	612
18	656	639	664
19	587	485	703
20	679	634	639
21	648	692	675
22	788	576	592
23	611	764	626
24	553	783	684
Av.....	645	641	653
One flower	3870[a]	3846[a]	3918[a]

[a] The number of pollen per flower was found by multiplying the respective average number of pollen per stamen by six.

TABLE 6

Size of pollen grains

POLLEN NUMBER	BINICOL	ININTIW	BINANGBANG
	Diameter	Diameter	Diameter
	microns	*microns*	*microns*
1	48.0	42.0	41.0
2	46.8	40.0	43.0
3	44.0	39.2	42.0
4	46.0	38.0	44.0
5	36.8	41.2	36.0
6	40.0	42.0	43.2
7	38.8	41.2	46.8
8	50.8	39.6	48.0
9	53.2	40.0	40.0
10	50.0	40.0	47.2
11	48.8	42.4	46.8
12	48.0	44.0	44.8
13	44.0	40.8	38.0
14	46.0	45.2	46.0
15	36.8	46.0	45.6
16	42.8	44.0	44.0
17	47.2	43.2	48.0
18	44.8	43.2	48.8
19	42.8	46.0	46.8
20	48.0	45.2	46.0
21	38.0	42.0	44.8
22	42.0	48.8	49.2
23	40.0	47.2	48.0
24	48.8	44.0	44.8
25	42.0	44.8	45.2
26	40.0	46.0	50.0
27	36.8	42.8	42.8
28	40.8	36.0	44.0
29	38.0	44.0	49.6
30	48.8	42.0	46.0
31	37.2	43.2	46.8
32	48.0	44.0	48.8
33	42.0	44.0	44.0
34	42.0	47.2	40.8
35	48.0	44.8	49.6
36	50.0	48.0	38.0
37	42.8	46.8	46.0
38	36.8	48.0	44.0
39	46.0	48.8	40.0
40	44.0	40.0	39.2
41	42.8	40.8	46.0
42	50.0	47.2	38.8
43	44.8	48.0	44.0
44	40.8	46.0	44.0
45	40.0	48.0	44.8
46	42.0	48.8	44.0
47	44.0	40.0	42.8
48	46.8	49.2	46.0
49	40.0	38.0	39.2
50	40.8	40.8	46.8
Av. . . .	43.95	43.65	44.48

TABLE 7

Comparative distances of the flight of pollen

DATE	AVERAGE NUMBER OF POLLEN GRAINS IN TWO SQ. CM. AT A DISTANCE OF:					VELOCITY OF WIND IN ONE DAY [a]
	25 cm.	50 cm.	100 cm.	150 cm.	200 cm.	
						mile
Dec. 29	23	7	1	0	0	67.1
Dec. 31	26	9	3	1	0	89.2
Jan. 3	27	8	4	2	0	85.3
Jan. 3	22	8	1	0	0	85.3
Jan. 4	22	8	5	3	1	117.3
Jan. 4	13	10	6	3	0	117.3
Jan. 6	19	7	2	1	0	108.6
Jan. 6	24	10	3	0	0	108.6
Jan. 8	28	9	6	2	0	81.3
Jan. 8	32	6	5	3	0	81.3
Jan. 9	21	13	4	1	0	133.8
Jan. 9	25	8	5	3	0	133.8
Jan. 18	16	7	3	1	0	85.4
Jan. 18	24	13	5	1	0	85.4
Jan. 21	17	4	1	1	0	80.8
Jan. 21	12	3	1	0	0	80.8
Av.....	21.9	8.1	3.4	1.4	0	

[a] Taken from Department of Plant Physiology.

TABLE 8

Observations on the time of opening of the rice flower

DATE	TIME OF OPENING			TEMPERATURE	CONDITION OF ATMOSPHERE
	First opening observed	Most flowers open	Last opening observed		
	a. m.	*a. m.*	*a. m.*	*Centigrade*	
BINICOL VARIETY					
Sept. 6, 1920.....	8:10	9:00–10:10	11:30	27.2	½ cloudy
Sept. 10, 1920.....	8:00	9:15–10:00	11:44	27.3	¾ cloudy
Sept. 11, 1920.....	6:25	9:10–10:20	12:15	28.1	¾ cloudy
Sept. 13, 1920.....	7:30	9:30–10:45	11:43	26.5	½ cloudy
ININTIW VARIETY					
Oct. 9, 1920.....	8:20	9:30–11:40	11:45	25.9	¾ cloudy
Oct. 10, 1920.....	8:25	10:00–10:50	11:37	26.4	½ cloudy
Oct. 11, 1920.....	8:2	9:00–10:00	11:43	26.8	¾ cloudy
Oct. 13, 1920.....	8:50	10:00–11:00	12:5	25.5	cloudy
Oct. 14, 1920.....	—	11:5 –11:45	12:20	25.5	cloudy
Oct. 15, 1920.....	8:50	10:30–11:5	11:40	25.1	cloudy
Oct. 16, 1920.....	—	11:10–11:55	12:17	25.2	cloudy
Oct. 17, 1920.....	9:00	11:5 –11:40	12:4	25.3	cloudy
BINANBANG VARIETY					
Oct. 20, 1920.....	9:20	11:15–11:50	12:25	24.8	cloudy
Oct. 22, 1920.....	8:55	10:30–11:20	11:50	25.8	cloudy
Oct. 23, 1920.....	9:5	11:00–11:45	12:10	25.0	cloudy
Oct. 25, 1920.....	8:30	10:40–11:30	12:15	25.7	cloudy

TABLE 9

Results of the test for natural cross-pollination, first generation

PARENT NUMBER	ININTIW				TADIOC			
	Number of progeny	Number of awnless progeny	Number of awned progeny	Number of hybrids	Number of progeny	Number of awned progeny	Number of awnless progeny	Number of hybrids
1	4	4	0	0	8	8	0	?[a]
2	4	4	0	0	8	8	0	?
3	11	10	1	1	11	11	0	?
4	1	1	0	0	6	6	0	?
5	6	6	0	0	11	11	0	?
6	8	8	0	0	6	6	0	?
7	5	5	0	0	5	5	0	?
8	2	2	0	0	3	3	0	?
Total..	41	40	1	1	58	58	0	?
per cent..				2.4				

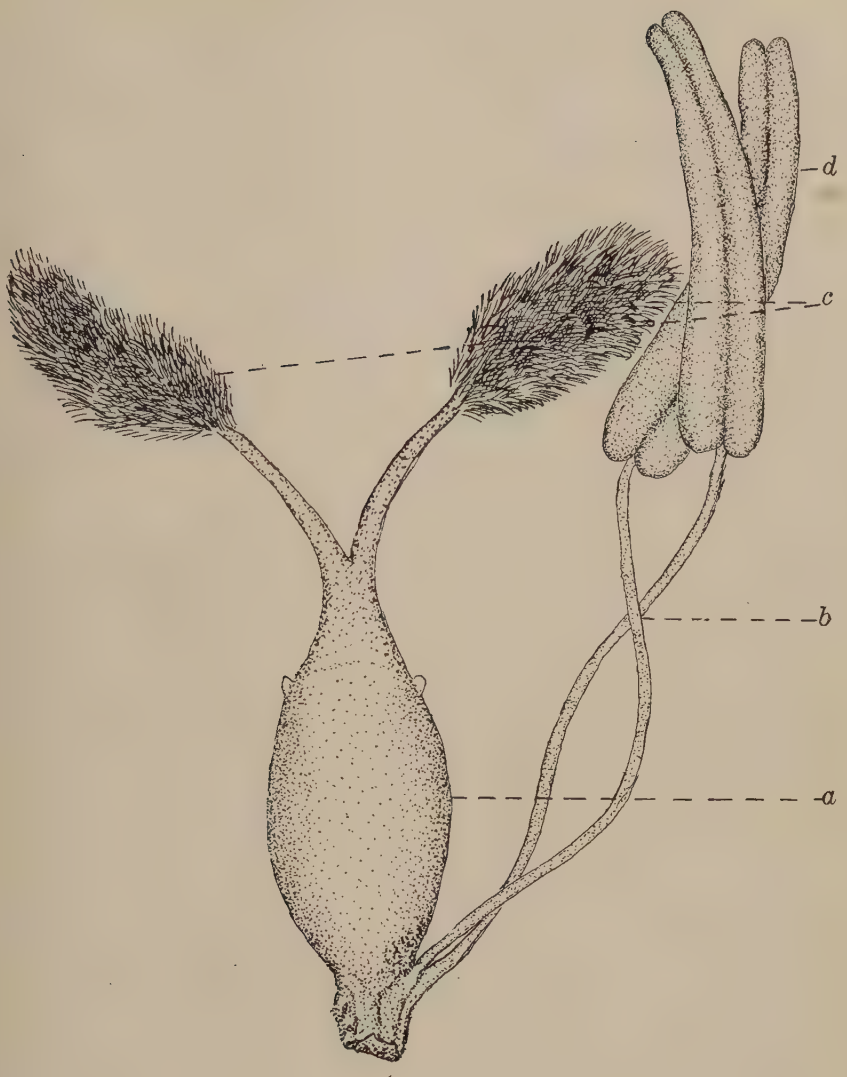
[a] To be filled in after the test for second generation is made.

TABLE 10

Results of the test of suspected artificial hybrids, first generation obtained in a reciprocal cross between Kinamaleg, a red hulled variety, and Kariit, a white hulled variety

PARENT NUMBER	HULL COLOR OF PARENTS AT MILK STAGE		OFFSPRING			TOTAL NUMBER OF SUSPECTED HYBRIDS	AVERAGE AGE OF FLOWERING	
	Male	Female	Red hulled	Variegated red and white hulled	White hulled		Suspected hybrids	Check[a]
							day	*day*
1	White	Red	1	0	0	1	103	110
2	White	Red	5	1	0	6	92	99
3	Red	White	0	4	2	6	106	106
4	Red	White	0	3	3	6	103	110
5	Red	White	0	3	2	5	100	109
6	Red	White	0	2	1	3	105	111
7	Red	White	0	2	1	3	104	112
8	Red	White	0	2	0	2	100	111
9	Red	White	0	0	2	2	68	57
10	White	Red	1	1	0	2	94	112
Total....			7	18	11	36		

[a] Checks are non-hybrid seeds from the same plants.



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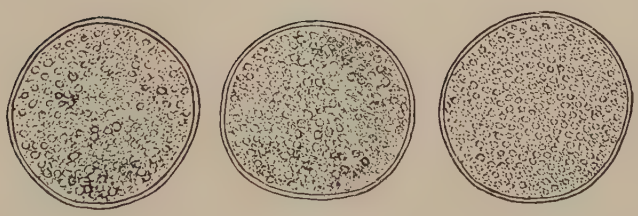
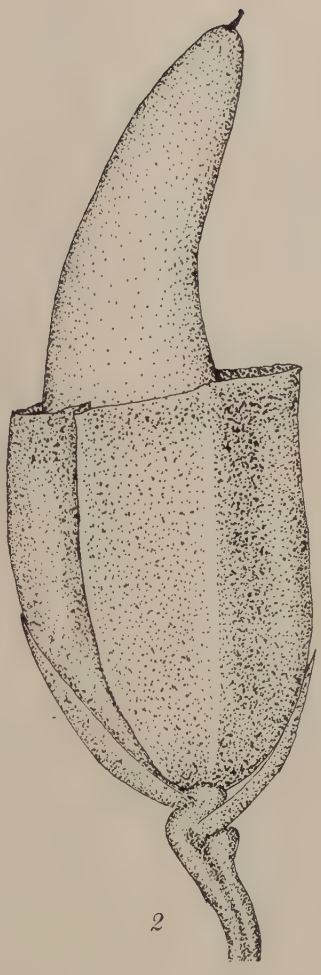


2

PLATE I

Fig. 1. Pistil and stamens (greatly enlarged):
(*a*) ovary; (*b*) filament; (*c*) stigma; (*d*) anther.
Fig. 2. Pollen grains as seen under high power microscope.

1



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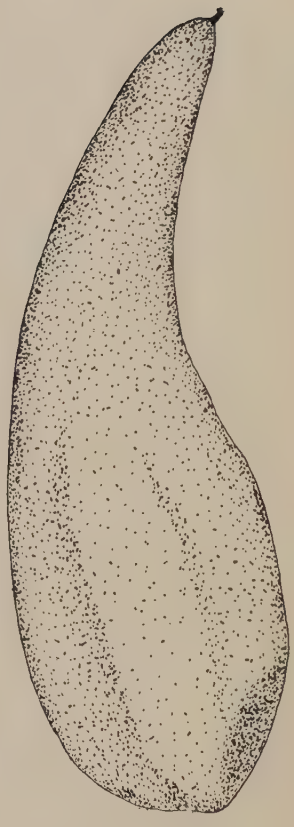

3

PLATE II

Fig. 1. A branch of a rice panicle showing some developed hybrid seeds; partly covered;
Fig. 2. Hybrid seed, partly covered (greatly enlarged);
Fig. 3. Hybrid seed, with hull removed (greatly enlarged).

THE EFFECT ON SOIL PHOSPHORUS OF RICE CULTURE[1]

ELIGIO C. URETA

INTRODUCTION

The relation of the amount of phosphorus in the soil to the growth and production of plants is a subject that has been for some time under investigation by a number of workers. Very little of this kind of work, however, has been done in the Philippines, except by way of studying the effect of phosphorus fertilizers on the yields of various crops.

It has become customary to speak of phosphorus in the soil as existing in various "forms". This statement is to some extent misleading, because, although the phosphorus does exist in the soil in different compounds, the "forms" of phosphorus usually spoken of refer to the amounts of phosphorus dissolved by different solvents. Thus we speak of total phosphorus, strong acid soluble phosphorus, active phosphorus, and water-soluble phosphorus. These different forms are, of course, not sharply differentiated and indicate only in a rough way the "availability" of the soil phosphorus.

Total phosphorus. By total phosphorus is meant the entire amount of phosphorus, usually calculated as P_2O_5, which exists in the soil. Experience shows that this is not all available to plants. In many cases even where the amount of total phosphorus in the soil is sufficient, plants require phosphoric fertilizers. The amount of total phosphorus thus shows the maximum amount that may ultimately be available for plant production. Hilgard (1911) says that highly productive soils in California, Texas, Louisiana, and Mississippi contain on the average about 0.26 per cent phosphoric acid (P_2O_5), and the lower limit of phosphoric acid for productiveness in Florida soils is about 0.1 per cent.

Strong acid soluble phosphorus. By strong acid soluble phosphorus is meant that portion of the soil phosphorus soluble in strong acid. As in the case of the total phosphorus, the strong acid soluble portion is not all available to plants. But it does give some index as to the amount available. Hilgard gives the following amounts of phosphoric acid as related to soil fertility:—poor soil, below 0.05 per cent; medium soil, 0.05—0.10 per cent; normal soil, 0.1—0.15 per cent; good soil, 0.15—0.25 per cent; rich soil, above 0.25 per cent. These standards when taken in connection with known physical conditions of the soil furnish the basis for an interpretation of the soil analysis. In the United States it has become generally accepted that if the soil contains more than 0.1 per cent of phosphoric acid (P_2O_5), strong acid soluble, it is not in immediate need of phosphorus fertilization. Cox (1911) and others working with Philippine soils have found percentages of phosphoric acid soluble in strong hydrochloric acid ranging from

[1] Thesis presented for graduation 1921 with degree of Bachelor of Agriculture from the College of Agriculture, No. 204; Experiment Station contribution No. 303. Prepared in the Department of Agricultural Chemistry under the direction of Professor F. W. Ashton. Revised by Dr. R. L. Pendleton, Division of Soils, Department of Agronomy.

less than 0.01 per cent to about 0.7 per cent, and hold that Philippine soils containing less than 0.1 per cent were generally to be classed as poor.

Active phosphorus. By "active phosphoric acid" Fraps (1910) means the phosphorus soluble in fifth normal nitric acid. He found that a soil containing active phosphorus (P_2O_5) to the extent of twenty parts per million (0.002%) to be highly deficient; twenty to 100 parts per million (0.002%—0.01%) usually deficient; one hundred to two hundred parts per million (0.01%—0.02%) possibly deficient; and two hundred parts or more per million not deficient with respect to phosphorus. Fraps also found (1915) that the amount of phosphorus removed in the cropping has practically no effect upon the amount of active phosphorus remaining in the soil at the end of the experiments. Shedd (1921), using the same concentration of nitric acid, held that 0.005—0.0075 per cent of phosphoric acid in a soil indicates a possible need of phosphorus.

Water-soluble phosphorus. The term water-soluble phosphorus is self-explanatory. It is the phosphorus entirely available to plants. Whitney and Cameron (1903) reported that the productive lands of Texas gave by water extraction 0.0018 per cent P_2O_5. Hilgard (1911) states that certain rich soils gave 0.00083 per cent water-soluble phosphoric acid (P_2O_5), and that poor soils gave only a trace of phosphoric acid (P_2O_5). A poor soil of California gave on water extraction 0.0072 per cent phosphoric acid, and highly productive soils gave as much as 0.0277 per cent. The relative amounts of these different forms of phosphorus are not constant. The decomposition of organic matter with the formation of carbon dioxide tends to convert the phosphorus compounds into more soluble forms. Among others, Bancroft and Firkins (1918) have shown that the decomposition of green manure crops makes rock phosphate soluble. Nitrification and sulfofication produce, respectively, nitric acid and sulfuric acid, and assist in this conversion.

This paper gives the result of a preliminary study on the relative amounts of the different forms of phosphorus in the soil on the College Farm at Los Baños, Laguna Province. The effects of growing two successive crops of rice are also given. Since one of these crops was fertilized, the effects of additions of superphosphate and lime were also obtained.

MATERIALS AND METHODS

Ten plots, each 3.4 by 2.45 meters, were used in this experiment. The soils were leveled and made as uniform as possible by forking and raking three times before each planting. The fertilizers used were single superphosphate and lime ($CaCO_3$).

The first crop grown received no fertilizer. For the second crop some of the plots, as shown in table 1, were fertilized with single superphosphate, and some with single superphosphate and lime.

TABLE 1

Showing the percentage of phosphorus, as (P_2O_5), and lime (CaO) added to the soil

PLOT NO.	AMOUNT OF SUPERPHOSPHATE ADDED	P_2O_5 IN SOIL	AMOUNT OF LIME ADDED	CALCIUM OXIDE IN THE SOIL
	kgm.	*per cent*	*kgm.*	*per cent*
1	1.28	0.0158	1.72	0.0462
2	check	———	———	———
3	5.12	0.0632	———	———
4	1.28	0.0158	———	———
5	check	———	———	———
6	2.56	0.0316	———	———
7	check	———	———	———
8	check	———	———	———
9	2.56	0.0316	2.40	0.0940
10	check	———	———	———

Rice of the Sanglay Puti variety "F_4-4494 selected" was used. The first crop was planted September 12, 1919, and was harvested January 24, 1920. The second crop, planted February 16, 1920, was not successful because of the season and parasites (root lice). It was turned under, and on June 23, 1920, was replanted. On August 5, it was noticed that the root lice were again attacking the plants. The plots were then fumigated by boring holes about sixty centimeters apart, pouring into each hole five cubic centimeters of carbon disulfide, and plugging the hole with soil. The plants wilted somewhat after the first application, but recovered in two or three days. On August 14, carbon disulfide was again applied, and after a week the plants improved. This crop was harvested October 17, 1920, but the data are not included in the discussion.

On August 21, all plots were divided diagonally, and on August 22, half of each plot was replanted. Since this crop was free from pests, the growth and production were very much greater than with the preceding crop; for this reason the effect on the crop of the phosphorus in the soil is significant. The plants were harvested January 7, 1921, by pulling them up. The roots were washed and the plants dried in the sun and weighed. The grain was then threshed and weighed.

At first the soil samples were obtained by digging holes twenty-five centimeters deep in different parts of the plot and slicing the sides of the holes for the samples. Later, however, the soil auger was used. The soil was then dried in the sun, pulverized and sifted through a two-millimeter sieve. The plots were sampled before and after each harvest, to show the effect of each crop on the soil phosphorus.

The fertilizers used were sampled by the usual method of quartering.

Since the first crop did not receive fertilizer, the samples for crop analysis were composites, made from two-gram lots of straw or grain from all plots. The crops resulting from the last harvest were sampled plot by plot by the usual method.

METHODS OF ANALYSIS

Water-soluble and strong acid soluble phosphorus were determined by the "Official Method," Wiley, (1907). Active phosphorus or the phosphorus extracted by fifth normal nitric acid was determined by Fraps' method (1910). Total phosphorus was determined by Fisher's method as given by Robinson (1916).

The total phosphorus in the grain and straw was determined by Christie's method (1916). The fertilizer was analysed in the same way as the soil. Total phosphorus was determined in the first and last samples only, but all other forms were determined in each sample. All results were calculated to the moisture-free basis; and also to the hectare basis for purposes of discussion. For a good general discussion of the numerous factors involved in the determination of phosphorus, see Hibbard (1913).

RESULTS

Data on the various forms of phosphorus in the soil are presented in table 2. The yields of grain and straw from the individual plots, and the amounts of phosphorus in the grain and straw are reported in a separate paper[2] since only the amounts per hectare of phosphorus removed by the crop are included in this report. In tables 3 to 9, inclusive, are grouped the data showing the effect of cropping and fertilizing on the different forms of phosphorus in the soil.

DISCUSSION OF RESULTS

In considering the results of the analysis, it must be borne in mind that the lack of adequate replications in the sampling of the plots will account for a considerable proportion of the differences in the various treatments. Also, the figures are calculated on the basis of phosphoric acid, although the expression "phosphorus" is used generally.

Effect of cropping on total phosphorus

It will be seen from table 3 that cropping decreased by about 5 per cent the amount of total phosphorus in the soil. This loss may be due to leaching, for the amount removed by the crop is less than 2 per cent of the total loss. The amount actually lost from the soil as a result of two unfertilized crops was 6.22 per cent of the amount originally present. It will also be noticed that the amount of phosphorus in the crop increases irregularly when fertilizer is added, and more phosphorus seems to be removed by the crop when the soil is treated with phosphorus and lime than when phosphorus alone is added, or when the plots remain unfertilized. The application of single superphosphate increased by 75 per cent the amount of phosphorus, as P_2O_5, removed from the fertilized plots over that removed from the check plots. The table also shows that fixation of phosphorus by the soil occurs during the growth of the crop, but neither the amount fixed nor its proportion to the amount added, is constant. Plot 1 treated with phosphorus and lime showed the highest percentage of fixation, the amount fixed being about 72 per cent of the P_2O_5 added. With twice the quantities of phosphorus and lime, however, the proportion fixed dropped to about 68 per cent of the amount added.

Analysis of the crop showed that the percentages of phosphorus in the straw and grain are not increased by the application of fertilizer, although the amount removed by the crop is increased by reason of increased yields.

Effect of cropping on strong hydrochloric acid soluble phosphorus

Table 4 shows that, just as in the case of total phosphorus, the amount soluble in strong hydrochloric acid decreased as a result of cropping. The loss due to the first cropping was 5.26 per cent of the strong acid soluble phosphorus

[2]Ureta, E. C. The effect of single-superphosphate and lime on the yield of rice. (Unpublished.)

in the soil. This loss, however, represents 3.83 per cent of the total phosphorus in the soil. From table 5 it appears that only 37.35 per cent of the strong acid soluble phosphorus as P_2O_5 added is recovered as such after cropping, the remainder having been leached out or rendered less soluble. The loss due to the second cropping was 5.11 per cent. This loss represents 3.65 per cent of the total phosphorus in the soil. The total loss of the strong acid soluble phosphorus due to two crops of rice on the basis of total phosphorus in the soil was 6.48 per cent. Since table 3 shows a loss of total phosphorus of only about 5 per cent as (P_2O_5) it would seem that a fairly large part of the strong acid soluble phosphorus had been converted to a less soluble form.

The addition of lime to the plot decreased the amount of soluble phosphorus remaining after cropping. Doubling the amounts of added phosphorus and lime in plot 9 gave a slight increase. The effect of lime on fixation of acid soluble phosphorus therefore cannot be stated.

It appears that the addition of superphosphate more than doubled the amounts of phosphorus removed by the crop, the average amounts being nine kilograms from the fertilized plot and four kilograms from the control pots.

In this experiment there seems to be no relation between the amount of acid soluble phosphorus added and that removed by the crop. Perhaps this is because the minimum amount added is more than the amount that is of greatest benefit to the crop.

Effect of cropping on active phosphorus

From table 6 it may be seen that cropping has caused a decrease in the amount of active phosphorus in the soil, except in plot 5. The average decrease is 2.8 per cent of P_2O_5. In table 7 the control plots show a slight and negligible decrease of active phosphorus. There would be an increase in active phosphorus of 2.45 per cent P_2O_5 if the amount removed by the crop were assumed to be active phosphorus. Therefore, the plants either absorbed phosphorus from more insoluble forms as well as from the active phosphorus, or the conversion of the more insoluble forms of phosphorus to active phosphorus is more rapid than the absorption of the active phosphorus by the plants. It may be seen from table 7 that only 1.3 per cent of the active phosphorus as (P_2O_5) added as fertilizer is fixed by the soil during cropping. In all cases, the higher percentage of phosphorus is fixed when the smaller amount of active phosphorus is added.

Effect of cropping on water-soluble phosphorus

Table 8 shows a decrease in the amount of water-soluble phosphorus, the average loss being 10.6 per cent of P_2O_5. Plot 5 is the only exception, with an increase of 11.7 per cent of P_2O_5. In table 9 the control plots have an average loss of 13.3 per cent of P_2O_5. There would be a gain of 6.1 per cent, however, if the amount removed by the crop be considered as water-soluble phosphorus. As in the case of the other forms of phosphorus, only a part of the water-soluble form furnished by the fertilizer is fixed by the soil.

SUMMARY

1. The growing of two crops of rice caused a reduction of 6.22 per cent of the total phosphorus (as P_2O_5) in the soil.

2. The loss of total phosphorus was 51.8 per cent of the amount, as P_2O_5, added; that removed by the crop was less than 2 per cent of the total amount lost.

3. The soil fixed 45.8 per cent of the total amount of phosphorus added.

4. A fairly large part of the strong acid soluble phosphorus seems to have been converted to a less soluble form.

5. Of the strong acid soluble phosphorus added, 37.35 per cent was recovered, as such, after cropping.

6. The amount of phosphorus soluble in N/5 nitric acid decreased as a result of cropping, the average decrease in the first crop being 2.8 per cent P_2O_5.

7. If the amount of phosphorus in the crop be considered active phosphorus, the loss amounted to only 0.005 per cent in the first crop. In the second crop the loss was 0.6 per cent.

8. From the above results it would seem either that the plants absorbed phosphorus which was not extracted by N/5 nitric acid or the conversion of phosphorus to the form soluble in N/5 nitric acid is more rapid than the absorption by the plant.

9. As a result of cropping, it seems that the total and hydrochloric acid soluble forms of phosphorus were reduced in amount. The N/5 nitric acid-soluble and water-soluble forms remained nearly constant or showed slight losses. If the phosphorus in the crop be considered as having come from this form, there appears to be a conversion of less soluble forms of phosphorus to the more available forms.

10. In view of the somewhat conflicting results and doubt as to the actual movements of phosphorus in the soil under consideration, a more thorough study of the movements of phosphorus in the soil is urged. Lysimeter studies should be especially desirable to determine the actual losses by leaching.

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TABLE 2

Showing percentages of various forms of phosphates before and after cropping

PLOT NO.	TOTAL P_2O_5		STRONG ACID SOLUBLE P_2O_5				N/5 HNO_3 SOLUBLE P_2O				WATER-SOLUBLE P_2O_5			
	Before planting	After second crop A	Before planting	After first crop	After second crop	After second crop A	Before planting	After first crop	After second crop	After second crop A	Before planting	After first crop	After second crop	After second crop A
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
1	0.42	0.41	0.32	0.31	0.32	0.311	0.0062	0.0059	0.0063	0.0062	0.0018	0.0012	0.0015	0.00155
2	0.42	0.40	0.32	0.30	0.30	0.285	0.0059	0.0055	0.0056	0.0055	0.0017	0.0012	0.0013	0.00115
3	0.40	0.42	0.30	0.28	0.30	0.293	0.0056	0.0051	0.0055	0.0055	0.0016	0.0014	0.0016	0.00145
4	0.40	0.40	0.29	0.28	0.29	0.285	0.0051	0.0049	0.0054	0.0053	0.0018	0.0016	0.0014	0.00135
5	0.40	0.38	0.27	0.26	0.25	0.243	0.0047	0.0048	0.0045	0.0053	0.0016	0.0017	0.0016	0.00142
6	0.37	0.39	0.27	0.26	0.28	0.273	0.0049	0.0049	0.0050	0.0049	0.0018	0.0017	0.0018	0.00183
7	0.40	0.37	0.30	0.28	0.28	0.273	0.0051	0.0050	0.0048	0.0051	0.0018	0.0015	0.0013	0.00135
8	0.42	0.39	0.32	0.29	0.28	0.276	0.0053	0.0052	0.0051	0.0050	0.0015	0.0013	0.0013	0.00130
9	0.41	0.43	0.31	0.29	0.31	0.305	0.0053	0.0053	0.0058	0.0056	0.0019	0.0016	0.0019	0.00170
10	0.43	0.40	0.31	0.30	0.29	0.277	0.0053	0.0052	0.0050	0.0049	0.0019	0.0018	0.0015	0.00135

TABLE 3

Showing the effect of two croppings and fertilizing on the total phosphate in the soil

PLOT NO.	PHOSPHORIC ACID (P_2O_5) PER HA./20 CM.						P_2O_5 LEACHED		LEACHED ON THE AMOUNT OF FERTILIZER ADDED
	Before planting	Added	After harvest	Loss	Fixed	Removed by 2 crops	Amount	Of total	
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*per cent*	*per cent*
1	10,730	380	11,990	—	260	15	105	0.95	27.6
2	10,730	—	10,220	510	—	8	502	4.7	——
3	10,220	1,520	10,730	—	510	13	997	8.5	65.6
4	10,220	380	10,220	—	—	12	368	3.6	96.8
5	10,220	—	9,710	510	—	6	504	4.9	——
6	9,450	760	9,960	—	510	11	239	2.4	31.4
7	10,220	—	9,450	770	—	7	763	7.5	——
8	10,730	—	9,970	760	—	8	752	7.0	——
9	10,480	760	10,940	—	460	13	287	2.7	37.8
10	10,990	—	10,220	770	—	8	762	7.0	——
Av.	10,397	760	10,240	664	348	10.1	527.9	4.93	51.8

Percentage P_2O_5 fixed on the amount added = 45.8

Percentage P_2O_5 loss on the check plots = 6.22

Percentage P_2O_5 removed by two crops on the total loss = 1.91

TABLE 4

Showing the effect of the first cropping on the strong acid soluble phosphate in the soil

PLOT NO.	PHOSPHORIC ACID (P_2O_5) PER HA./20 CM.				P_2O_5 LEACHED	
	Before planting	After harvest	Loss	Removed by crop	Amount	On total
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*per cent*
1	8,180	7,920	260	5	255	3.1
2	8,180	7,670	510	4	506	6.2
3	7,670	7,150	520	4	516	6.0
4	7,410	7,150	260	3	257	3.4
5	6,900	6,640	260	2	258	3.9
6	6,900	6,640	260	3	257	3.8
7	7,670	7,150	520	3	517	6.7
8	8,180	7,410	770	4	766	9.3
9	7,920	7,410	510	4	506	6.4
10	7,920	7,670	250	4	246	3.1
Av.	7,693	7,281	412	3.6	408.4	5.26

Loss on the basis of total P_2O_5 (10397) = 3.83 per cent.

TABLE 5

Showing the effect of the second cropping and fertilizing on the strong acid soluble phosphoric acid in the soil

PLOT NO.	PHOSPHORIC ACID (P_2O_5) PER HA./20 CM.						P_2O_5 LEACHED		LEACHED ON THE AMOUNT ADDED
	Before planting	Added	After planting	Loss	Fixed	Removed by second crop	Amount	On total	
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*per cent*	*per cent*
1	7,920	325	7,946	—	26	10	289	3.5	88.9
2	7,670	——	7,282	388	——	4	384	5.0	——
3	7,155	1320	7,486	—	336	9	975	11.0	73.9
4	7,150	325	7,282	—	132	9	184	2.5	56.6
5	6,640	——	6,209	431	——	4	427	6.4	——
6	6,640	650	6,975	—	335	8	307	4.1	47.2
7	7,150	——	6,975	175	——	4	171	2.8	——
8	7,410	——	7,052	358	——	4	354	4.8	——
9	7,410	650	7,793	—	383	9	258	3.2	39.3
10	7,670	——	7,077	593	——	4	589	7.7	——
Av..	7,281	650			242.8	6.5	393.8	5.11	59.18

Percentage fixed on the amount added = 37.35

Percentage loss on the basis of total P_2O_5 (10,777) = 3.65

TABLE 6

Showing the effect of the first cropping on the active phosphoric acid in the soil

PLOT NO.	PHOSPHORIC ACID (P_2O_5) PER HA./20 CM.					P_2O_5 LEACHED OR FIXED	
	Before planting	After harvest	Loss	Fixed	Removed by crop	Amount	On total
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*per cent*
1	158	151	7	—	5	2	1.30
2	149	140	9	—	4	5	3.40
3	143	130	13	—	4	9	6.30
4	129	125	4	—	3	1	0.77
5	120	123	—	3	2	+5	+4.16
6	125	125	0	—	3	+3	+2.40
7	130	127	3	—	3	0	0.00
8	134	132	2	—	4	+2	+1.56
9	135	135	0	—	4	+4	+2.96
10	135	132	3	—	4	+1	+ .74
Av.	135.8	132					

Loss = 2.8 per cent.

TABLE 7

Showing the effect of the second cropping and fertilizing on the active phosphoric acid in the soil

PLOT NO.	PHOSPHORIC ACID (P_2O_5) PER HA./20 CM.						P_2O_5 LEACHED OR FIXED		
	Before planting	Added	After harvest	Loss	Fixed	Removed by second crop	Amount	On total	Leached on the amount added
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*per cent*	*per cent*
1	151	263	157	—	6	10	-247	59.60	94.00
2	140	——	139	1	—	4	+3	+ 2.10	——
3	130	1052	140	—	10	9	1033	87.13	98.20
4	125	263	136	—	11	9	243	62.90	92.40
5	123	——	135	—	12	4	+16	+13.00	——
6	125	526	124	1	—	8	519	79.70	98.70
7	127	——	123	4	—	4	0	0.00	——
8	132	——	128	4	—	4	0	0.00	——
9	135	526	144	—	9	9	608	76.80	96.60
10	132	——	125	7	—	4	3	2.30	——
Av.	132	526							95.98

Average loss on check plots = 3.2 kilograms P_2O_5.
Average gain on check plots = 2.4 kilograms P_2O_5.
Amount removed by crops on check plots = 4.0 kilograms P_2O_5.
Amount fixed on check plots by crops as active P_2O_5 = 2.45 per cent.
P_2O_5 fixed on fertilized plots = 1.33 per cent.

TABLE 8

Showing the effect of the first cropping on the "water-soluble phosphate" in the coil

PLOT NO.	PHOSPHORIC ACID (P_2O_5) PER HA./20 CM.					P_2O_5 LEACHED OR FIXED	
	Before planting	After harvest	Loss	Gain	Removed by crop	Amount	Of total
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*per cent*
1	46.0	31.2	4.8	——	5	0.2	0.40
2	42.2	30.7	11.5	——	4	7.5	17.80
3	39.6	35.8	3.8	——	4	+ .2	+ 0.50
4	44.7	39.6	5.1	——	3	2.1	4.70
5	39.6	42.1	——	2.5	2	+4.5	+11.70
6	45.2	43.4	1.8	——	3	+1.2	+ 2.70
7	42.2	38.3	3.9	——	3	0.9	2.10
8	38.3	33.2	5.1	——	4	1.1	+ 2.80
9	47.3	39.6	7.7	——	4	3.7	7.80
10	48.6	44.6	4.0	——	4	0.0	0.00
Av.	43.37			2.5			2.07

Loss on water soluble P_2O_5 = 10.6 per cent.

TABLE 9

Showing the effect of the second crop and fertilizing on the "water-soluble phosphate" in the soil

PLOT NO.	PHOSPHORIC ACID (P_2O_5) PER HA./20 CM.						P_2O_5 LEACHED OR FIXED		LEACHED ON THE AMOUNT ADDED
	Before planting	Added	After harvest	Loss	Fixed	Removed by second crop	Amount	Of total	
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*per cent*	*per cent*
1	31.20	214.2	39.6	——	8.00	10	195.8	79,90	91.40
2	30.70	——	39.3	1.40	——	4	+2.6	+8.50	——
3	35.80	856.6	37.0	——	1.20	9	846.4	94.90	98.80
4	49.60	214.2	34.5	5.10	——	9	210.3	82.90	98.10
5	42.10	——	36.2	5.90	——	4	1.9	4.50	——
6	43.40	428.3	46.8	——	3.40	8	416.9	92.60	97.30
7	38.30	——	34.5	3.80	——	4	+0.2	+0.50	——
8	32.20	——	33.2	——	——	4	+4.0	+12.00	——
9	39.60	428.3	43.4	——	3.80	9	415.5	88.80	97.00
10	44.60	——	35.5	9.10	——	4	5.1	11.40	——
Av.	37.85	428.3							96.52

Average loss on check plots = 13.3 per cent.

Gain on check plots considering the amount removed by crop as water soluble = 6.1 per cent.

NOTES ON SOFT ROT OF RADISH[1]

E. F. ROLDAN[2]

Of the Department of Plant Pathology

WITH ONE PLATE

The writer noted wilting of 40 per cent of the radishes (*Raphanus sativus* L.) in the experimental plot of the Department of Plant Pathology, College of Agriculture, Los Baños, Philippines. Cultural characters showed that the organism is probably *Bacillus carotovorus* Jones (1901a, 1901b) first reported on radish in the Philippines by Reinking (1918).

SYMPTOMS OF THE RADISH SOFT ROT IN LOS BAÑOS

In the field the first symptom of the disease is wilting of the leaves, especially of the young ones. As the disease advances all the leaves wilt, fall over, and finally rot. When the leaves fall over the underground portions are completely rotted. The rot is confined to the underground portions. Infection may start from any point on the subterranean portion and spread throughout the entire fleshy tissue. When infected subterranean parts are cut open they show water-soaked, brown to dark colored lesions (plate I, fig. 1), sometimes covering the entire fleshy portion depending on the age of the disease. Black streaks or discolorations may be seen in the lesion. Bacterial ooze is not infrequently found on the cut of the lesions.

CAUSAL ORGANISM

Morphology

The bacterium is a short rod with rounded ends. In 48-hour cultures in peptonized beef bouillon the rods occur either singly or in chains. The rods vary from 0.8–2.2×0.5–0.8 μ and the chains may be from 5.0 to 15.0 μ. In most cultures the organism when emulsified in distilled water showed active motility. The organism is peritrichiately flagellate and the flagella are from two to six (plate I, fig. 2). The flagella were demonstrated by using either Muir Pitfield's modified method or Casares-Gil stain.[3] Neither capsule nor spores were found in cultures.

Staining reaction

The bacterium is readily stained with carbol fuchsin, Loefler's alkaline methylene blue, and carbol gentian violet. It is non-acid fast and Gram negative.

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[1] Experiment Station contribution No. 304.

[2] The writer wishes to thank Dr. G. O. Ocfemia of the Department of Plant Pathology for suggestions in the preparation of the paper.

[3] The writer expresses appreciation of the courtesy of Miss Mary K. Bryan, of U. S. Department of Agriculture, in sending him directions as to the Casares-Gil method of staining flagella.

Pathogenicity

Positive results of inoculation on the roots of radish were secured by needle pricks using fresh cultures on peptonized beef agar or nutrient broth. The period of incubation under controlled conditions ranges from five to eight days. Inoculations made on mustard (*Brassica juncea* (L.) Coss.), lettuce (*Lactuca sativa* L.), pechay (*Brassica pekinensis* (Lour.) Skeels), fruits of tomatoes (*Lycopersicum esculentum* Mill.), and pepper (*Capsicum annum* L.) gave positive results. Soft rot was invariably developed on them and on other vegetables with the same incubation period as that on radish.

Cultural Studies[4]

Peptonized beef agar plates. Surface colonies and thin plates of buried colonies were visible after 24 hours. The surface colonies are from 0.4 to 1.0 mm. in diameter and gradually increase in size up to 2.0 to 5.0 mm. in three to five days. Surface and thinly sown colonies are circular, sometimes irregular, smooth, shiny, dirty-white, opalescent, slightly raised, and convex. The internal structure is coarse, granular, or grumose as seen under the high power of the microscope with oblique transmitted light. Deeply buried colonies are fusiform, or spindle shaped, or occasionally oval. In old colonies a thin shade may be seen surrounding them. The consistency is slightly viscid.

Peptonized beef agar slants. Streak cultures on agar slants showed moderate growth which was filiform, slightly spreading, white, smooth, glistening, opaque to opalescent. Edge entire. Old cultures did not cover the entire surface of the medium but produced a considerable precipitate at the base of the streak. The consistency was slimy. No change in color of the medium was produced.

Potato plug. The growth was moderate or abundant, filiform, spreading at the base, glistening, white, smooth and slightly raised. No distinct change of medium in one week old cultures was noted. Slight gray coloration was produced in about three weeks. Old cultures showed only a partial digestion of starch.

Peptonized beef bouillon. In peptonized beef bouillon the organism showed a decided clouding after 24 hours, with thin pellicle on the surface. Upon slight agitation the pellicle disappeared. Clouding became more and more pronounced as the culture became older, and persisted for about a week. Sediment was formed in abundance. The odor was decided. A month old culture showed a slimy or viscous consistency. The medium turned blue litmus red.

Fermentation tests

Fermentation media were prepared in fermentation tubes containing peptonized beef bouillon adjusted to + 13 Fuller scale. One per cent solution of mannite, saccharose, dextrose, glycerine, and lactose were prepared. Growth in all of the fermentation media was indicated by clouding after 24 hours except in glycerine where growth was slightly slower than in the others. The clouding of all solutions became more evident as the cultures became old. Pellicles developed in all of them with abundant sediment. After five days, slight gas production was observed in tubes containing one per cent saccharose and one per cent dex-

[4] The cultural studies were made in the Plant Pathology Laboratory with a room temperature ranging from 28°–30° throughout the experiment.

trose. On the sixth day gas formation was noted in tubes containing one per cent lactose. On the eighth day gas was evolved in tubes containing one per cent mannite, while in glycerine, no gas formation was noted.

Cohn's solution. No growth occurred.

Uschinsky's solution. Clouding was slow at the beginning, but it became more and more pronounced after three to four days. Formation of thin pellicle was observed. The pellicle was easily separated when slightly disturbed.

Bacto purple milk solution. On account of the bluish purple color of the milk the growth was not noticeable after 24 hours. After two days the growth was detected by the change of color of the milk to yellowish. After a week the milk turned pale yellow, but was not coagulated. The surface cleared to about three to five millimeters in depth. The yellow color indicated the change of the solution to acidic reaction.

Dunham's peptone solution. In this solution the organism showed weak growth as indicated by faint clouding after 24 hours. Clouding became decided in the days following but not as heavy as in peptonized beef bouillon culture. Cloudiness was uniform and persistent for about a week but without the formation of pellicle or sediment.

Indol test

Indol production was tested by using Dunham's culture tubes, but the culture showed only a very slight formation.

Desiccation

Following the same method used by Jones (1901b) for the study of the effect of desiccation, cover slips with dry bacterial films were placed in a culture case having a temperature of 28°–30° C. The cover slips were desiccated for one, two, three, four and five hours. They were tested by dropping them in test tubes containing peptonized beef bouillon. After 24 hours, clouding was noted in the tubes in which the film was desiccated for one hour, feeble growth in two hours, and none in three, four, and five hours.

Thermal death point

The thermal death point was determined by inoculating peptonized beef bouillon which was adjusted to + 13 Fuller scale and tubed in 7.5×0.7 cm. test tubes. The cultures were immersed for 10 minutes in water with constant and definite temperatures ranging from 40° to 55° C. It was shown that the organism in test tubes immersed for 10 minutes in water at 52° C. did not produce growth. At 50° and 51° C. the growth was shown by faint clouding.

Sodium chloride toleration

The organism tolerates as high as four per cent sodium chloride, or four grams of sodium chloride dissolved in 100 cc. of peptonized beef bouillon. The medium was first adjusted to + 13 Fuller scale before the salt was added. One to two per cent sodium chloride does not affect the growth as shown by the prompt clouding of the broth after 24 hours. In three per cent sodium chloride growth was slow and in four per cent, clouding was feeble but became strong when a week or more old. In five per cent sodium chloride, growth was not produced.

Taxonomy

A thorough study of the physiological characters of the organism causing soft rot of radish in Los Baños was not made. Certain phases of the physiological study was studied and the results seem to show that the organism under consideration is the same as the *Bacillus carotovorus* Jones which was reported on radish in the Philippines by Reinking in 1918.

CONTROL

Jones (1901) recommends that root crops or any other vegetable susceptible to the disease should be carefully cultivated so as not to wound the roots as the soft rot organism is a wound parasite. Roots with wounds should not be kept unless they are carefully disinfected. Compost material from waste vegetables infected by the disease should not be used for manure. Roots harvested and intended for storage should be thoroughly air dried before putting in storage.

SUMMARY

1. The soft rot of radish and other vegetables occurs in the United States, Europe, and the Philippines.

2. Under favorable conditions the disease may become destructive, causing serious damage on radish and other vegetables.

3. The soft rot of radish in the Philippines is caused by *Bacillus carotovorus* Jones.

4. The organism isolated from soft rot of radish is pathogenic on radish, pechay, mustard, lettuce, tomato, and pepper.

5. Rotation of crops leaving out susceptible plants for a few years; desiccation, or allowing root surfaces to dry thoroughly before storage; allowing harvested roots to lie as long as practicable exposed to sunlight; and low temperature of storage room without freezing, are measures recommended to control the disease.

LITERATURE CITED

JONES, L. R. 1901. Bacillus carotovorus n. sp. die Ursache einer weichen Faulnis. Centralbl. f. Bakt. **7**: 12-16.

JONES, L. R. 1901. A soft rot of carrot and other vegetables. Rept. Vermont Agric. Exper. Sta. 1899-1900: 301-332. *Fig. 1-11.*

REINKING, OTTO A. 1918. Philippine economic plant diseases. Philippine Jour. Sci. Sec. A. **13**: 165-274. *Pl. 1-12, fig. 1-43.*

ILLUSTRATIONS

PLATE I

Fig. 1. Chinese white radishes showing symptoms of the soft rot produced under field conditions slightly reduced. The first two were cut longitudinally to show the soft and discolored rotting tissues in the center. This rotting travels with rapidity through the central pithy portion. (Photograph by the Photographic Division, Department of Agronomy, College of Agriculture, Los Baños).

Fig. 2. A photograph of the organism from a slide stained with Casares-Gil flagella stain showing two to six peritrichiate flagella. (Photomicrograph by the Bureau of Science, Manila, P. I.).

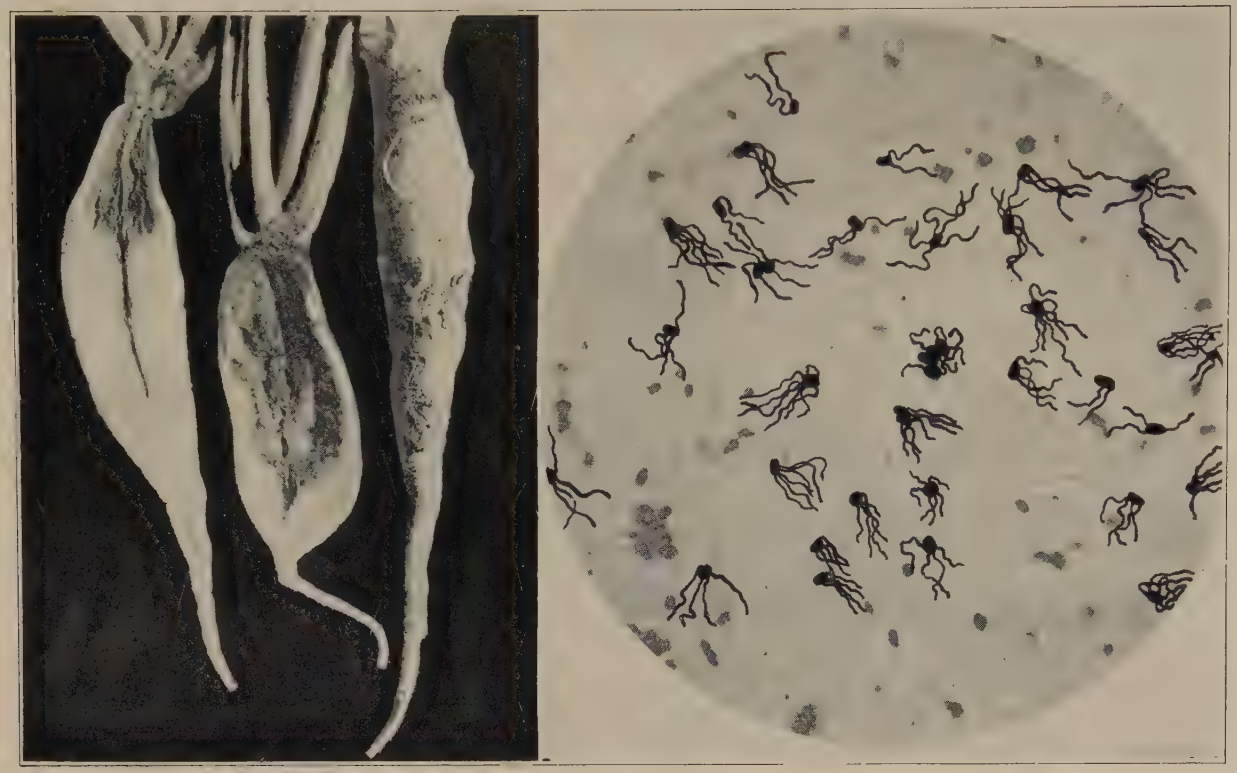

Figure 1 Figure 2

PLATE I

NOTE: THE LOS BAÑOS BIOLOGICAL CLUB

The first meeting of the Club for the College year was held June 25. The following papers were read:

1. A Case of Polyembryony in Rice by Mr. P. A. Rodrigo.
2. Origin and Development of the College Strain of Cantonese Chickens by Dr. F. M. Fronda.
3. Observations on the Intraperitoneal Injections of Blood in Dogs. Preliminary Report by Dr. G. San Agustin, Mr. M. Muñoz, and Mr. M. M. Robles. Paper read by Dr. G. San Agustin.
4. Drafts of Walking Plows by Prof. A. L. Teodoro.

The standard of the Club with regard to the quality of papers presented is: (*a*) That the papers shall be accompanied by actual results on some specific investigation; (*b*) That work performed in the Philippine field shall have precedence over work done elsewhere.

President Palma Commends Los Baños Biological Club

In a letter written to Dr. N. B. Mendiola, President of the Club, recently, President Palma said:

I have just learned of the existence of such a club through the kindness of Professor Hester in sending me a report of the retiring officers. The brief report submitted shows the extent and importance of the club's activities. I like the mission of the association, and I wish we had more of its kind in the University to encourage research among the faculty ranks. I hope the club, under its new officers, will continue and improve on the already auspicious record of the past two years of its existence. Please convey to the retiring officers my congratulations for their splendid record.

The Club Should be Kept Going Whether it Receives any Public Acclaim or Not

Extracts from a letter written by Dean C. F. Baker to Dr. B. M. Gonzalez upon his retiring from the presidency of the Los Baños Biological Club in March, 1925:

* * * * * * * * * * * * * * * *

During the last 38 years I have been connected with many such clubs. I have never seen any of them that were able to draw and hold a large continuous interest. Special public programs of unusual interest would usually draw a good size crowd, but in almost all cases the regular life of the club and its activities were restricted to a small group of devoted men whose vital interests were so keen and rare that the club was bound to live on, if at all, through this interest of the small group and primarily for their own benefit. In a great many instances I have seen such clubs formed and built up and held up by the interest and devotedness of one person. In these cases, the life of the club has been solely a question of the efforts of one person and when he was sick or absent or quit the place, the club immediately became non-existent.

I have watched the formation and development of your club and it has been a satisfaction to observe that a number of strong, active, enterprising men have been concerned in it. This is its best promise of continued life. It is a particularly happy circumstance that its progress and its success have not hung upon the backing or any other outlay of energy on the part of the Dean. I have seen a great many organizations of this kind here and elsewhere brought into

being because it was called into being or forced into existence by the direct wishes of some Dean, rather than because of voluntary desires on the part of some faculty group, and organizations of this sort very rarely possess the possibility of continued successful independent life.

Also I regard your club as a very important experiment and a demonstration in another direction where such demonstration is most strongly to be hoped for. Many Filipinos have now obtained technical training and it remains to be proven if they are capable of developing smoothly working co-operative bodies of the many different types needed in any progressive country. I have watched the life and operation of the "Society of Technical Agriculturists" with the very keenest interest. Devotion to science just as in devotion to the well-being of one's country or people, if it is real, will inevitably furnish some of the strongest animating motives that may come into a man's life, and also, if real, will inevitably make possible the necessary self-sacrifice, patience, and long-suffering with the faults of others, that are absolutely necessary in the successful maintenance of any co-operative human relations. It seems to me that the rising generation of Filipino technical men are daily demonstrating their possibilities in this most important of all directions and that your Biological Club is merely a case in point. I hope that you will keep it going whether it receives any public recognition or acclaim or not, or whether you can secure any actual attendance beyond the limited number of active members or not. I hope you will resolutely carry on since a good deal of the material prepared for presentation of this club will also be valuable for purposes of publication. I remember a meeting just a year ago at which I gave a talk on the meaning to the country of certain types of technical work. Portions of that talk I afterward presented as an editorial in the PHILIPPINE AGRICULTURIST under the title of "The Stone Rejected," and it happened that that particular editorial had a great deal of effective influence both in this country and abroad, since in several cases it resulted in decisive official action. It is thus that the proceedings of your club will often give rise to an output that may have no little educational and constructive value.

EXCHANGE NOTES

Chinese citrus growers in Szewui, P'unu, and other fruit producing districts of Kwantung commonly practice the culture of an ant which they claim kills off destructive insects, and is therefore a very necessary adjunct to successful citrus culture. . . . Mr. Gist Gee's compilation of Chinese ants leads us to record our observations of this ant, *Oecophylla smaragdina* Fabr., the well-known red tree ant of the Old World Tropics. . . .

When we questioned the efficacy of this practice the growers insisted that as long as they have strong colonies in their trees they are never troubled with *Tesseratoma papillosa*, the stink bug insects which prove so injurious to lychee and citrus fruits. They also claimed that they keep away boring insects. They said that when other insects come to eat the flowers or fruit these ants quickly attack them. They had found by actual experience that when they do not have these nests in the trees very few fruits form and those that do drop to the ground or develop with blemish. . . .

It is interesting that this practice should be continued to the present day in these parts of China. The advantages of the practice have not been scientifically established.

—*Lingnaam Agricultural Review* (Canton Christian College, Canton.)

Eat lettuce and onions for worn nerves. Beets and turnips give iron to the blood. Tomatoes stimulate a torpid liver. Celery is good for rheumatism. Beetroots are nourishing and laxative. Carrots cleanse the blood and clear the

complexion. Asparagus is beneficial to the kidneys. All kinds of greens in spring help to cleanse the blood and regulate the system.

—*The Journal of the Madras Agricultural Student's Union* (taken from *The Scottish Farmer*).

Dr. Roxas' paper on variety tests appearing in this issue (April) is one of the most important contributions on the subject which have appeared in the sugar press in the past ten years.

—*Sugar Central and Planters News* (Philippines).

The use of coffee as a beverage in England dates back to about 1652, long before tea had found its way to that country, but tea has increased in popular favor and left coffee far behind.

Coffee is believed to have originated in the highlands of Abyssinia. During the latter part of the 17th and during the 18th centuries it was introduced into Java, Jamaica, Martinique, and Brazil and since that time has been cultivated in nearly every portion of the tropics. . . .

Of the British Dominions, South Africa is the only one where coffee is used on a large scale, the per capita consumption being something over 4 lb. per annum.

The United States of America, using about 11 lb. per capita, is the ultimate market for about half the world's total production.

—*Tropical Agriculture.*

We advise "clean cultivation" for bananas always . . . but we certainly do not advocate the stripping of the trees. . . . Banana cultivators must remember that banana stalks are soft and full of moisture and if the natural protection,—the dried leaves and trash which hang around them—, is cut clean away they are then too exposed to drying. . . .

"Clean cultivation" means that the *field* should be kept clean, particularly round the roots of the bananas. . . .

The trees should never be stripped till the "pink" appears, only dead trash should be pulled off and then it should be *grasped at the bottom and torn upwards*, if it is torn downwards green protecting folds are soon destroyed and wounds made in the tree.

The dry leaves hanging round should not be cut off at their points of connection with the tree, they need not be cut off at all except, of course, what is required to wrap the fruit for conveyance to a depot or if they are long enough to foul the lower parts of the tree, then just enough should be cut off to prevent this.

—*The Journal of the Jamaica Agricultural Society.*

It is conservatively estimated that there is an area of at least 300,000 acres of Nipah Palm occurring in British North Borneo, available in blocks up to 5,000 acres. These areas extend up the river estuaries for distances of about nine or ten miles with a depth varying from a few chains to a mile.

In the naturally occurring state the palms grow so thickly that penetration is difficult and they flower but rarely.

—*The Malayan Agricultural Journal.*

Every trained teacher, every thorough-going research worker, and every wide-awake extension specialist in live stock throughout not only the South but the entire nation, realizes that the biggest problem before him today is that of properly feeding live stock. Not only is this true in the daily routine of the farmer who is keeping live stock, but deeper lying than all is the fact that the South has at least three major problems which only trained nutritional workers will be able to solve, if at all. These three problems are as follows:

First. Soft pork produced from feeds, such as peanuts and soybeans, two of the South's staple crops.

Second. The problem of cottonseed meal "toxicity" or "deficiency," or possibly both.

Third. The problem of so feeding dairy cattle that the butter manufactured from milk so produced will not be discriminated against on the large markets as it now is.

—*The Progressive Farmer* (Alabama, U. S.).

COLLEGE AND ALUMNI NOTES

During the summer recess Professor Higgins, Head, Department of Agronomy made a trip through parts of the Mountain Province with the object of investigating the possibilities of extending the culture of avocado in that region. Professor Higgins was accompanied by Mrs. Higgins, also an enthusiast over the outlook for avocado in the Philippines.

Assistant Professor O'Leary of the English Department spent two weeks of the summer recess at Camp Stotsenburg in required annual training as Federal Reserve Officer. The rest of the vacation Mr. O'Leary spent in Manila giving some time each day to the study of Spanish.

An article, "Women, as Managers of Philippine Farms," by Miss Arsenia Goco appeared in the April number of *The Woman's Outlook* (Manila). Miss Goco was a student in our College in 1923-1924. Her attitude on women studying agriculture is expressed in the following passage: "If our women would only study in the College of Agriculture, these farms would receive a very much better management. By the application of knowledge learned in the College, great improvement would be made in the methods of tilling the soil, in planting, and in all other lines of farming. Less expense and greater returns could be expected if the women had knowledge of farm accounting."

A clipping from a Zamboanga newspaper tells of the marriage of Mr. Fernando Luistro, B. Agr. '16, and Miss Trining Santos, daughter of Captain Santos, P.C. Mr. Luistro is superintendent of "Balactan Scientific Center" on Basilan Island, Mindanao.

Mr. Arsenio Goco, B. Agr. '17, writes his brother, Gregorio Goco of this College that he has resigned from the Bureau of Agriculture where he was for several years supervising plant inspector, and gone to farming. He has invested his savings in a farm in Imus, Cavite. He will engage in truck farming which

he believes offers him a brighter future than employment in government work. He will carry on with his farming the management of the budding of his pomelo seedlings, which number about 10,000.

The following review of "Preparation of Scientific and Technical Papers" by Sam F. Trelease and Emma Sarepta Yule appeared in the April number of *Industrial and Engineering Chemistry.*

The reader as well as the editor of technical literature always welcomes any aid to improved writing. Hence the editors and readers alike will hope for much benefit from the wide use among students of this little volume of which the authors say, "We hope that it may be of service to students in other colleges." In it the authors have practiced as they preached, for they have given a well-balanced, carefully prepared, skilfully manufactured style book.

The book will be to the experienced writer or editor, however, something of a disappointment. It is little more than a style book for the inexperienced. But if that class is served, much good will be done, for the clear writing of good English in concise form is an art which needs much cultivation.

In one section of ten pages, General Suggestions on Subject Matter and Arrangement, the authors have presented the fundamental principles of good writing. This portion cannot be too strongly commended. Some of the particularly fine paragraphs deserve special mention. In discussing "tone," the authors say: Skill may be developed in presenting material in a tactful way. Clear statements supported by evidence are better than positive assertions. Be careful not to announce a well-known fact as if it were a discovery."

The purpose of a summary is splendidly defined in a brief sentence: "Your summary should tell him at a glance whether or not he should read your article." The length of an article is well defined in the irrefutable test set forth: "In judging, put yourself in the place of the reader. Be impersonal, a difficult thing when estimating your own work. It takes moral strength to 'blue pencil' choice phrases, paragraphs, and ideas. But the results will justify the effort."

Teachers will do well to require perusal of this book on the part of their students. No one can demand rigid enforcement of all detailed recommendations, for matters of "style" are necessarily matters of opinion. But in the main the authors have very skilfully selected from conflicting styles that which is best and most widely accepted, and there is no better test of good style than wide acceptance.

—R. S. McBride.

Books Added to the Library of the College of Agriculture, March-May, 1925

Allen, James Lane
The choir invisible—1899.
Allen, James Lane
A Kentucky cardinal—1913.
Arrhenius, Svante
Worlds in the making—1908.
Barclay, Florence L.
The rosary—1910.
Barrie, J. M., et al
Stories by English authors—1896.
Barrie, J. M.
The Admirable Crichton—1919.
Beard, Charles A.
Economic origin of Jeffersonian democracy—1915.
Bray, Mary Mathews
A sea trip in clipper ship days—1920.
Canfield, Dorothy
The bent twig—1916.
Carroll, Lewis
Alice's adventures in wonderland.

Cattell, J. McKeen
American men of science—1910.
Cecil, Lord Hugh
Conservatism.
Cheradame, André
The pan-German plot unmasked—1917.
Cobb, Irvin S.
"Speaking of Prussians"—1917.
Conklin, Edwin Grant
The direction of human evolution—1921.
Conner, Ralph
Black rock.
Conner, Ralph
To him that hath—1921.
Crawford, F. Marion
Don Orsino—1892.
Crawford, F. Marion
The heart of Rome—1903.
Crawford, F. Marion
In the palace of the king—1901.
Cumberland, William W.
Cooperative marketing—1917.
Cunliffe, J. W.
Poems of the great war—1918.
Downy, David G. (editor)
Doctrine and discipline of the Methodist Episcopal church—1920.
Ford, Paul L.
Janice Meredith—1899.
Fothergill, Jessie
The first violin.
Fox, John J.
The Little Shepherd of Kingdom Come—1903.
Gerard, James W.
My four years in Germany—1917.
Grayson, David
Hempfield—1915.
Hall, James Norman, et al (editors)
The Lafayette flying corps, vols. 1-2—1920.
Haney, John Louis (editor)
Shakespeare's Mid-summer's Night dream—1911
Harland, Henry
The cardinal's snuff-box—1900.
Harrison, Henry S.
Queed—1911.
Henry, O.
Strictly business—1916.
Henry, O.
Cabbages and kings—1904.
Hegan, Alice C.
Mrs. Wiggs of the cabbage patch—1901.
Hill, Howard Copeland
Community life and civic problems—1922.
Japan. Cabinet Impérial. Bureau de la Statistique générale. Résumé statistique de l'Empire du Japon—1924.
Johnston, Mary
To have and to hold—1900.
Johnston, Robert M.
General Foch—1918.

Jones, Donald Forsha
Genetics in plant and animal improvement—1925.
Innes, Arthur D. (editor)
The tragedy of Julius Caesar—1903.
Innes, Arthur D. (editor)
Shakespeare's Twelfth Night—1896.
Kipling, Rudyard
The light that failed.
Kipling, Rudyard
Soldiers three.
Knowles, Frederic L.
A treasury of humorous poetry—1917.
Little, Frances
The lady of the decoration—1907.
London, Jack
The call of the wild.
Lorimer, George H.
Letters from a self-made merchant to his son—1905.
McCutcheon, George Barr
Beverly of Graustark—1904.
Meredith, Owen
Lucile.
Maurier, George du
Peter Ibbetson—1891.
Neilson, William Allan (editor)
Milton's minor poems—1903.
Nicholson, Meredith
The house of a thousand candles—1905.
Norris, Frank
The pit—1903.
Nystrom, Paul H.
The economics of retailing—1917.
Ollivant, Alfred
Bob, son of battle—1900.
Parker, Gilbert
The battle of the strong—1798.
Quiller-Couch (editor)
The Oxford book of English verse—1916.
Reade, Charles
The cloister and the hearth.
Rinehart, Mary Robert
The window at the white cat—1910.
Scott, Walter
Guy Mannering, or the astrologer.
Scott, Walter
Kenilworth.
Selby, F. G. (editor)
Burke's speeches on American taxation on conciliation with America and letter to the sheriffs of Bristol—1901.
Shute, Henry A.
The real dairy of a real boy—1903.
Siam Dept. of Commerce and Statistics. Statistical year book of the Kingdom of Siam—1919.
Smith, C. Alphonso
New words self-defined—1919.
Smith, F. Hopkinson
Caleb West, master driver—1899.

Smith, F. Hopkinson
Colonel Carter of Cartersville and other tales—1891.
Sonnichsen, Albert
Consumers' cooperation—1919.
Splawn, W. M. W., and Bizzell, W. B.
Introduction to the study of ecomonics—1923.
Sprague, Homer P. (editor)
Shakespeare's comedy of As You Like It—1896.
Stevenson, Robert Louis
The Master of Ballantrae—1909.
Stevenson, Robert Louis
The poems and ballads of Robert Louis Stevenson—1913.
Tarkington, Booth
The gentleman from Indiana—1902.
Tennyson, Alfred
The poetic and dramatic works—1898.
Thackeray, William M.
The Newcomes.
Thackeray, William M.
The history of Pendennis, his fortunes and misfortunes.
Thompson, Maurice
Alice of old Vincennes—1900.
Wagner, Charles
On life's threshold—1905.
Wallace, L. E.
The Prince of India.
Waller, M. E.
The wood-carver of 'Lympus—1906.
Ward, Mrs. Humphry
Marcella—1894.
Wells, Webster
The essentials of geometry—1899.
White, William Allen
A certain rich man—1909.
Wilkins, Mary E.
The portion of labor—1901.
Winters, Laurence M.
Animal breeding—1925.
Wright, Harold Bell
The winning of Barbara Worth.